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Volume 20, Number 15, August 15, 1966

NUCLEAR SCIENCE ABSTRACTS

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NUCLEAR SCIENCE ABSTRACTS

BIOLOGY AND MEDICINE

General

26593 THE FATE OF ISOTOPE-LABELLED UTERINE SPERMATOZOA IN THE MOUSE POST COITUM. Reid, B. L. (Univ. of Sydney). Austral. J. Zool., 13: 525-31(Oct. 1965).

Technics are described for producing isotopically labeled sperm in two ways. To obtain tritiated thymidine-labeled sperm, normal adult male mice were injected intraperitoneally with a 40 μC daily dose of tritiated thymidine for 10 days. From 35 to 37 days later the animals were killed and both epididymides removed. These organs were then minced with scissors and the sperm washed from them with normal saline. In the second method, employing irradiation with tritium gas, sperm was removed from the epididymal canal as described above, and washed in deionized distilled water several times to reduce the amount of ionized material in the vehicle, dried, and lyophilized. The dried sperm was exposed to 7 C of tritium gas for 10 days. The irradiated sperm were resuspended in distilled water, washed three times, and finally washed in normal saline. Both types of isotopically labeled sperm were used to investigate the fate of the uterine sperm residue. A portion of the sperm present in the uterus exhibiting a copulation plug was removed and replaced by intrauterine injection of labeled sperm. Exposure to a tritium source for labeling was found more suitable for tracer use although the results with both methods were qualitatively similar. Seventeen hours after injection, label was present in sperm in the lumen, in debris associated with polymorphonuclear granulocytes and monocytes in the lumen, in the epithelial and subepithelial coats of the mucosa, and in phagocytic cells of the lower abdominal lymph nodes and spleen. The density of labeling was greatest in the sperm itself then fell away sharply and uniformly in the other sites. The relation between the density of labeling and the degree of degradation of the sperm products is discussed and it is reasoned that the female cells are exposed to less degraded sperm products as a result of entry via the peritoneal cavity than entry via the uterine mucosa. This route may be thereby more effective as an antigenic stimulant. (BBB)

26594 PARTICULATE CHROMIC PHOSPHATE: COLLOID CHARACTERISTICS SUITABLE FOR MEASUREMENT OF LIVER CIRCULATION. Dobson, Ernest L.; Finkelstein, Lawrence J.; Finney, Caroline R.; Kelly, Lola S. (Univ. of California, Berkeley). pp 477-502 of CONF-651111.

The exponential disappearance of intravenously injected colloidal chromic phosphate from the blood and the use of the disappearance rate in estimating liver blood flow are reviewed. The characteristics of a colloid that contribute to its suitability for the measurement of liver circulation are large particles (approximately 1 μ in diameter for chromic phosphate); relatively few in number (about 10^4 per microliter of blood); and not stabilized. Small stabilized particles (colloid carbon) present in great numbers (about 10^{11} per microliter of blood) are cleared very slowly and are useful in measuring relative phagocytic activity of the reticuloendothelial system but are not useful for the measurement of liver circulation. Distribution studies in mice and disappearance rates of chromic phosphate measured on large numbers of dogs and mice are presented. These indexes are the only standards available at present for judging the suitability of a preparation for the measurement of liver circulation. Physical criteria of suitability would be more desirable, and some are suggested for chromic phosphate; but they have not been extensively investigated and cannot yet be adopted as standards. A method for preparing chromic phosphate that has proved to be very suitable for use in measuring liver circulation is presented in detail. (auth)

Ecology

26595 (AE-219) PHYTOPLANKTON FROM LAKE MAGELUNGEN, CENTRAL SWEDEN, 1960-1963. Willen, Torbjorn (Aktiebolaget Atomenergi, Stockholm (Sweden)). Mar. 1966. 45p. Dep. mn.

An investigation was made of the qualitative and quantitative composition of phytoplankton in Lake Magelungen, Central Sweden, over a period of three years to illustrate the conditions before the release of waste water from the Ågesta Heat and Power Station began. Vertical sampling series were taken about once a month and samples from three different stations in the lake were analyzed and compared. (C.H.)

26596 (NP-16002) ANNUAL REPORT, 1965. Preprints of Reports on Research Carried out in 1965. (Helsinki Univ. (Finland). Dept. of Radiochemistry). 1966. 105p. Dep. mn.

Research progress is reported in nine papers. Separate abstracts were prepared for each paper. (J.R.D.)

For abstracts of individual papers see: 26597-26605.

26597 (NP-16002, Paper 1) INVESTIGATIONS OF RADIOACTIVITY IN MAN AND HIS ENVIRONMENT IN THE FINNISH LAPLAND. Miettinen, Jorma K. (Helsinki Univ. (Finland). Dept. of Radiochemistry). 15p.

Results of research concerning fallout from nuclear explosions are presented. Most effort was devoted to a study of Northern Lapland. Technology was developed toward capacities to make reliable predictions if new fallout situations arise. (J.R.D.)

26598 (NP-16002, Paper 2) BIOLOGICAL HALF LIFE OF ^{137}Cs IN PERCH (PERCA FLUVIATILIS L.). Hasanen, Erkki; Kolehmainen, Seppo; Miettinen, Jorma K. (Helsinki Univ. (Finland). Dept. of Radiochemistry). 9p.

Experiments are described in which the biological half-life of ^{137}Cs in fish from a eurotrophic fresh-water lake is determined. Data are included on ^{137}Cs excretion and retention by fish. The design of a whole-body counter for live fish is described. (J.R.D.)

26599 (NP–16002, Paper 3) ^{137}Cs IN FINNISH LAPPS AND OTHER FINNS IN 1962–65. Miettinen, Jorma K.; Hasanen, Erkki (Helsinki Univ. (Finland). Dept. of Radiochemistry). 15p. (CONF-660405–6).

Results of investigations concerning the food chain lichen-reindeer-man are presented. Data obtained in a dietary survey of the Lapps are included along with whole-body counting data. Information is included on ^{137}Cs in lichens and reindeer, and on ^{137}Cs body burden in humans. (J.R.D.)

26600 (NP–16002, Paper 4) MICROELEMENT LEVELS IN ENVIRONMENTAL SAMPLES IN FINLAND. Jaakkola, T.; Puumala, Heli; Miettinen, J. K. (Helsinki Univ. (Finland). Dept. of Radiochemistry). 15p. (CONF-660405–7).

Environmental radioactivity measurements using atomic absorption spectrophotometry on samples of surface water, plankton, higher plants, and animal tissues are reported. Techniques and results are discussed and evaluated. (J.R.D.)

26601 (NP–16002, Paper 5) ^{210}Po AND ^{210}Pb IN ENVIRONMENTAL SAMPLES IN FINLAND. Kauranen, Pentti; Miettinen, Jorma K. (Helsinki Univ. (Finland). Dept. of Radiochemistry). 9p. (CONF-660405–8).

Results of investigations are presented concerning food chains, especially the arctic food chain lichen-reindeer-man transmitting ^{210}Po and ^{210}Pb from fallout to man. Plant and reindeer samples were collected from Lapland and southern Finland, and analyzed for these isotopes. Human blood samples were also analyzed. (J.R.D.)

26602 (NP–16002, Paper 6) ^{55}Fe AND STABLE IRON IN SOME ENVIRONMENTAL SAMPLES IN FINLAND. Jaakkola, Timo (Helsinki Univ. (Finland). Dept. of Radiochemistry). 8p. (CONF-660405–9).

Results of analyses of lichens, and samples of reindeer blood and tissue for total Fe and for ^{55}Fe are presented. Analytical results for Fe are also included for blood samples from Lapp reindeer breeders. (J.R.D.)

26603 (NP–16002, Paper 7) BIOLOGICAL HALF LIFE OF ^{137}Cs IN THREE SPECIES OF FRESH WATER FISH: PERCH, ROACH AND RAINBOW TROUT. Kolehmainen, Seppo; Miettinen, Jorma K. (Helsinki Univ. (Finland). Dept. of Radiochemistry). 8p. (CONF-660405–10).

The first measurements were made at the beginning of June and the last ones at the end of Nov. In this way, estimations of temperature effects were also possible. (J.R.D.)

26604 (NP–16002, Paper 8) ^{137}Cs IN FISH, PLANKTON AND PLANTS IN FINNISH LAKES DURING 1964–65. Kolehmainen, Seppo; Hasanen, Erkki; Miettinen, Jorma K. (Helsinki Univ. (Finland). Dept. of Radiochemistry). 12p. (CONF-660405–11).

Results of chemical and radiochemical investigations of 26 lakes, four rivers, and the Gulf of Finland are reported. (J.R.D.)

26605 (NP–16002, Paper 9) ^{137}Cs IN SOME FINNISH DIETS IN 1962. Jokelainen, Aili (Helsinki Univ. (Finland). Dept. of Radiochemistry). 10p. (CONF-660405–12).

Results of a dietary survey of families in Finnish Lapland are presented. These data were correlated with data on ^{137}Cs content of the diet food, and data on ^{137}Cs body burden. (J.R.D.)

26606 (TID–22870) RADIOACTIVITY TRANSPORT IN WATER—TRANSPORT OF NITROSYLRUTHENIUM IN AN AQUATIC ENVIRONMENT. Technical Report No. 9. Bhagat, S. K.; Gloyna, E. F. (Texas Univ., Austin. Environmental Health Engineering Research Lab.). Nov. 1, 1965. Contract AT(11-1)-490. 159p. (EHE–11-6502; CRWR–3). Dep. mn. CFSTI $5.00 cy, $1.00 mn.

The net transport of ruthenium complexes in an aquatic environment is reported. Measurements were made to establish the relative transport of nitrosylruthenium and ruthenium chloride. To establish common transport criteria, the roles of suspended material, bottom sediments, and rooted plants were evaluated. Similarly, the distributions of ruthenium in both flowing and non-flowing ecosystems were compared such that predictions as to the fate of ruthenium released to larger and more dynamic waterways can be made more effectively. The results indicate that the transport of ruthenium in an aqueous environment is affected by chemical form of the ruthenium, pH, relative amount of suspended material, and the hydraulic characteristics of the stream. The net transport of nitrosylruthenium was high compared with that of ruthenium chloride. The detention of both nitrosylruthenium and ruthenium chloride by the sediments was maximum in near neutral pH environments. In a flowing system, the greatest fraction of ruthenium remained in solution. Under conditions of induced turbidity, the largest fraction became equally distributed between the solution and the suspended material. It is expected that under normal stream conditions, the largest fraction of ruthenium would be transported downstream. However, the bottom sediments would become the largest detention reservoir for ruthenium in a non-flowing system. (auth)

26607 (TID–22873) RADIOACTIVITY TRANSPORT IN WATER. STRUCTURE AND METABOLISM OF A LOTIC COMMUNITY. PART I (APRIL–JULY 1964). Copeland, B. J.; Gloyna, E. F. (Texas Univ., Austin. Environmental Health Engineering Research Lab.). Feb. 1, 1965. Contract AT(11-1)-490. 62p. (EHE–02-6501(Pt.1)). Dep. mn. CFSTI $3.00 cy, $0.75 mn.

The various aspects of community metabolism of animals and plants under simulated stream conditions were studied. Calculations were made of total solar input, photosynthetically available light, oxygen and carbon dioxide photosynthesis, oxygen and carbon dioxide respiration, efficiency of the ecosystem, photosynthesis/respiration ratios, and photosynthetic and respiratory quotients. The relation of community metabolism to radionuclide transport and its possible role in future considerations were evaluated. The community metabolism characteristics were at times different from those expected for flowing ecosystems. However, owing to the paucity of similar data for natural or artificial streams, it is not known whether these simulated stream values are to be considered typical or atypical. It was concluded that the relationship of photosynthesis to respiration (P/R ratios) is the prime factor in the uptake and release of ^{65}Zn and ^{58}Co in plants, water, and sediment. Carbon dioxide metabolism appeared to give the most realistic results, since oxygen metabolism values seemed to be affected by the anaerobic phase of the diurnal cycle. (auth)

26608 (TID–22876) RADIOACTIVITY TRANSPORT IN WATER—THE TRANSPORT OF ^{65}Zn IN AN AQUEOUS ENVIRONMENT. Technical Report No. 5. Rowe, D. R.; Gloyna, E. F. (Texas Univ., Austin. Environmental Health Engineering Research Lab.). Sept. 1, 1964. Contract AT (11-1)-490. 114p. (EHE–09-6403). Dep. mn. CFSTI $4.00 cy, $0.75 mn.

The transport of ^{65}Zn under simulated river conditions was evaluated. Measurements were made of the distribution of ^{65}Zn among the sediment, plants, solution, and suspended material in a research flume. For purposes of comparison, a prior study was conducted to examine the uptake and release of ^{65}Zn among the components of a small-scale, closed ecological system, and detailed laboratory tests were made on the uptake and release of ^{65}Zn by clay minerals and Lake Austin sediment. In the flowing system the greatest fraction of ^{65}Zn was associated with the solution and suspended material. It is expected that under actual river conditions, the greatest fraction of ^{65}Zn would be continuously transported downstream. On the other hand, the sediment in the non-flowing ecological system retained the greatest fraction of the originally-released ^{65}Zn. It is therefore expected that ^{65}Zn in a non-flowing system such as a lake would become mainly associated with the bottom sediment. However, for rooted and macroscopic plants grown in either the closed or

flowing ecological systems, there appears to be no significant difference in the uptake of ^{65}Zn. It is considered that photosynthesis is the prime element in the uptake and release of ^{65}Zn in plants. (auth)

26609 FALLOUT RADIONUCLIDES IN ALASKAN FOOD CHAINS. Hanson, W. C. (Battelle Memorial Inst., Richland, Wash.). Amer. J. Vet. Res., 27: 359-66(Jan. 1966).

Results of radioecologic research in northern Alaskan ecosystems during the period 1959-1965 are reviewed. Strontium-90, iodine-131, and cesium-137 were found to be the most important fallout radionuclides from a public health standpoint. Iodine-131 concentrations in caribou thyroid glands usually obtained maximum values about 2 months following atmospheric nuclear weapons tests. Alaskan samples usually peaked about 6 days earlier than, and at levels about one-half of, samples from Colorado deer. Measurable amounts of ^{131}I were in thyroid glands for about 4 months following the last nuclear test, but radiation doses absorbed by the glands were much less than those at which damage might occur. Strontium-90 and ^{137}Cs concentrations in Alaskan Arctic biota increased gradually from 1959 through 1962, and then increased rapidly. The lichen-caribou-man food web maintains radionuclide levels greater than in most other ecosystem components. Strontium-90 concentrations in caribou bone samples from northwestern Alaska increased from about 10 to 20 pC/g of dry weight during 1960–1961 to about 50 pC/g in 1964. Concentrations in caribou bone were 3 to 4 times those in lichens and about 1000 times those in caribou flesh. Strontium-90 ingestion rates of Anaktuvuk Pass Eskimos from caribou meat were within recommended radiation protection guides. Cesium-137 concentrations in lichens doubled from 1962 to 1964. Greater than average precipitation may have been a major cause of the increase. Cesium-137 concentrations in lichens were about 7 times those of ^{90}Sr; among caribou flesh samples the $^{137}Cs:{}^{90}Sr$ ratio was about 800. Caribou flesh ^{137}Cs concentrations changed greatly with season. Minimums occurred during summer periods with green forage and maximums during winter when lichens formed the diet. (BBB)

26610 CONCENTRATION OF ^{90}Sr IN SEA WATER IN THE PLANKTON OF THE ADRIATIC AND LIGURIAN-TYRRHENIAN SEAS DURING 1960 TO 1964 AND THE RELATIVE CONCENTRATION FACTORS. Schreiber, Bruno; Cerrai, Enrico; Triulzi, Cesare; Pelati, Laura Tassi. Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur., 38: 948-59(June 1965). (In Italian). (TID–22114).

From 1960 to 1964 the ^{90}Sr content in the water and plankton of the Adriatic and Ligurian-Tyrrhenian Seas was determined and the concentration factors were calculated. The same values were determined for the cuttle-fish bone for comparison. An increase in the radioactivity from ^{90}Sr was found in both the Ligurian-Tyrrhenian and Adriatic Seas in the middle of 1961, and this increase reached its maximum in 1963. The Adriatic water shows a higher ^{90}Sr concentration than the Ligurian Sea, but the reverse is true of the plankton. This is true for both the absolute values and the concentration factor which is 12 times higher in the Ligurian-Tyrrhenian Sea than in the Adriatic Sea. It is believed that this difference is due to the constant presence of Acantharia in the Ligurian Sea. These protozoa therefore must be considered as specific scavengers of strontium and its radioisotopes. (tr-auth)

26611 RADIATION HAZARDS OF THE NEW GENERATION OF ACCELERATORS. Thomas, Ralph H. (Rutherford High Energy Lab., Didcot, Eng.). Nucleonics, 24: No. 4, 64-9(Apr. 1966).

The radiation hazards and shielding for accelerators are discussed. The electron and proton machines, and proton machines including the 200-Bev synchrotron, and active-gas hazards are considered. Characteristics of some accelerators, shielding required for strongly interacting particles, and typical levels in beam-dump water are given. (J.F.P.)

Metabolism, Tissue Distribution, and Toxicology

Refer also to abstracts 27028–27030, 27032, 27194, and 27206.

26612 RETENTION OF ^{85}Sr IN RATS. II. EFFECT OF VARIOUS BARIUM SULFATE PREPARATIONS AS INFLUENCED BY SOLUBLE SULFATES, CARRIER STRONTIUM AND BY THE PHYSIOLOGIC STATE OF ANIMALS. Volf, Vladimir; Roth, Zdenek (Inst. of Radiation Hygiene, Prague. Inst. of Industrial Hygiene and Occupational Diseases, Prague). Acta Radiol. Therapy, Phys., Biol., 4: 113-28(Apr. 1966).

The average effect of various barium sulfates differed substantially but always increased excretion of ^{85}Sr considerably in the presence of soluble sulfates. The action of sulfates was only slightly influenced by carrier strontium. Barium sulfate in fed animals decreased the retention of ^{85}Sr only in combination with sodium sulfate. (auth)

26613 EFFECT OF SOIL MINERALS ON THE UPTAKE OF ^{90}Sr BY PLANTS. Gulyakin, I. V.; Udintseva, E. V.; Levina, E. M. (Moscow Biophysical Lab.). Agrokhimiya, No. 3, 111-20(Mar. 1966). (In Russian).

Experimental results showed that the type of soil formation, content of minerals and clays, and the content of minerals with different degrees of stability affects the binding of radiostrontium and at the same time reduces the uptake of this nuclide by plants. Clays of the Montmorillonite group of minerals, characterized by a high absorptive capacity because of the structure of the crystal lattice, adsorb radiostrontium very stably and sharply reduce its uptake in plants and accumulation in crops more effective than minerals of the hydromica group, mica, and kaolinite groups. The different effects on the uptake of ^{90}Sr in plants are representative of the individual micas and hydromicas. Vermicullite, hydrophlogopite, biopite, and phlogopite decrease the absorption of ^{90}Sr in plants although to a lesser degree than the clays of the Montmorillonite groups, and muscovite and damourite do not reduce the accumulation of radiostrontium in oat crops. A slight effect on the uptake of ^{90}Sr is caused by kaolinite evidently because its absorption takes place only on the surface layers of the crystalline lattice. (tr-auth)

26614 EFFECT OF FERTILIZERS ON YIELD AND RADIOACTIVITY LEVEL OF ALPINE MEADOW PLANTS. Ananyan, V. L. (Lab. of Agricultural Chemistry, Academy of Sciences, Erevan). Agrokhimiya, No. 3, 121-6 (Mar. 1966). (In Russian).

The results of field tests showed that the soils of high Alpine meadows were lacking in nitrogen and in phosphorus. The greatest increase of harvest was produced by fertilizers containing these elements plus K. The levels of total β activity and the radioactivities produced by other isotopes (fission products) were measured in fertilized and nonfertilized areas. The lowest level of total β radioactivity was detected in plant samples from acreages receiving complete mineral fertilization. (C.H.)

26615 STUDIES ON THE ENRICHMENT OF ^{3}H–CYCLOPHOSPHAMIDE IN NORMAL AND TUMOR TISSUES OF THE BRAIN. Schaumloeffel, E.; Graul, E. H.; Simon, G.; Hundeshagen, H.; Wilmanns, H. (Philipps-Univ., Marburg, Ger.). Atompraxis, 12: 140-2(Mar. 1966). (In German).

Studies were made on the distribution of ^{3}H-cyclophosphamide by patients (i.v. injection) with brain tumor. A quick passage of the blood-liquor-barrier was followed by a relatively high concentration of cyclophosphamide in the liquor. Cyclophosphamide was enriched in the normal tissue and in the tumor tissue of the brain. There was no selective enrichment of cyclophosphamide in tumor tissues. The concentration of cyclophosphamide in different tumor tissues was clearly shown to be directly related to the vascular supply of the tissue and it thus depended on the bloodflow through the tissue. (auth)

26616 REPEATED USE OF ^{3}H-THYMIDINE LABELING OF DNA WITH REGENERATING ADRENAL CELLS. Nekhlyudova, M. Ya. (Pirogov Second State Medical Inst., Moscow). Byull. Eksp. Biol. Med., 61: No. 1, 73-6(Jan. 1966). (In Russian).

Mice were given intra-abdominal injection of ^{3}H-thymidine 24 hours before adrenals excision. On the third day after the operation a considerable increase in the thymidine index was noted in all adrenal layers operated upon the medullar layer. The increase was particularly notable in the fascicular zone of the cortex and in the connective tissue elements of the subcapsular layer, which was markedly thickened after the operation. The accumulation of label took place in the absence of free ^{3}H-thymidine in the blood plasma. Hence it is suggested that DNA metabolic products may be reutilized. (H.G.D.)

26617 APPLICATION OF THE AUTOHISTORADIOGRAPHICAL METHOD TO THE STUDY OF THE HISTOLOGICAL LOCALIZATION OF CALCIUM AND STRONTIUM PRESENT IN VEGETABLE TISSUE. Myttenaere, C. (CEN, Mol, Belg.); Mousny, J. M. Int. J. Appl. Radiat. Isotop., 17: 287-91(May 1966). (In French).

A modified procedure for the autohistoradiographical localization of strontium and calcium ions in plant material using the techniques of freeze substitution and liquid emulsion is described. (auth)

26618 TRANSFER OF $^{152-4}$Eu TO THE OFFSPRING DURING PREGNANCY AND LACTATION. Lubin, E.; Neharin, A. (Soreq Nuclear Research Centre, Yavneh, Israel). Int. J. Appl. Radiat. Isotop., 17: 301-3(May 1966).

Radioisotope transfer to the offspring during pregnancy and lactation was studied on 20 mice 2.5 months old. They were injected intraperitoneally with 2 μC/0.25 ml of $^{152-4}$Eu-citrate. At the age of 3 months the treated females were mated with untreated males. The body burden of the tracer was measured daily from the beginning of the experiment using a single-channel γ spectrometer. The offspring were counted immediately after birth as whole litters. Two more measurements were made at 11 and 23 days. The values obtained were divided by the number of individuals in the litter to give the mean body burden of the isotope per offspring. It is shown that during pregnancy there exists a very small but significant transport from mother to fetus. There was a tendency in all offspring for the body burden to increase during early lactation. On the 11th day the activity was 6 times that at birth; it dropped to a value twice that at birth by the 23rd day. The extent of transfer during pregnancy depends on the nature of the lanthanide, the placental permeability, and the availability of the contaminant. (F.J.H.)

26619 DISTRIBUTION OF ^{232}Th IN THE ORGANS OF ALBINO RATS. Kendysh, I. N. Med. Radiol., 10: 46-9 (Oct, 1965). (In Russian).

The distribution and elimination of ^{232}Th nitrate was investigated after a single peroral (100 mg of Th metal/1 kg body weight), interperitoneal (100 mg of Th metal/1 kg), or intratracheal (10 mg/1 kg) administration to rats. The ^{232}Th content in the lungs, kidneys, spleen, liver, skeleton, blood, and gastrointestinal tract was determined 3 hours, 1, 5, 15, 30, 90, 150, and 250 days after inoculation with the activity. Due to a tendency to hydrolyze at the pH of the body, the ^{232}Th nitrate was poorly resorbed into the organs. The ^{232}Th was eliminated mainly with the feces, and to a lesser extent, with the urine. With peroral administration, 91.2% was eliminated with the feces and 3.8% with the urine after 10 days; with an intratracheal dose the respective figures were 23.6 and 4.7%; with intraperitoneal administration the values were 0.73 and 0.11% of the administered dose. The largest amount of isotope was eliminated in the first 10 days. Then the rate of elimination fell to about 0.002% of the administered dose per day. (TTT)

26620 EXPERIMENTAL RESEARCH ON THE LEUKOPENIC EFFECT FOLLOWING THE ANTIMITOTIC-IONIZING RADIATION ASSOCIATION. EFFECT OF DRUGS WITH A PROTECTING AND STIMULATING ACTION IN LEUKOPOIESIS. Agati, G.; Stoppa, I. M.; Toscano, G. (Univ., Turin). Minerva Radiol., Fisioterap. Radiobiol., 10: 629-37(Dec. 1965). (In Italian).

Numerous investigations on the various aspects of the leukopenic effect observed after the administration of antimitotic drugs associated with ionizing radiations are considered. The variation of the effect was evaluated with respect to dose, various chronological associations of the two treatments, and especially the effect of the protective drugs cysteamine, DPN, ascorbic acid, 4-chlorotestosterone acetate, albema (a composition of benzimidyl-1 (piridylcarbonamide)-2-propanol, sodium thiopropanate, and sodium cobaltithiopropanate), and lysozyme (a protein formed by a single peptide chain of 129 amino acids bound by 4 disulfide bridges). The results are shown graphically and are evaluated with respect to the present knowledge of the mechanism of the action of associated chemo-radiotherapy and of the substance used for protection. (tr-auth)

26621 EFFECT OF CHLORANILIC, TARTARIC, MALIC, AND OXALIC ACIDS ON THE TRANSPORT OF STRONTIUM WITHIN PLANTS. Sakaguchi, Takashi (Miyazaki Univ., Japan). Miyazaki Daigaku Gakugeigakubu Kiyo, Shizen Kagaku, 20: 53-7(Feb. 1966).

The possible inhibiting effects of chloranilic, malic, oxalic, and tartaric acids on the transport of strontium in plants was investigated as a means of decreasing the radioactive contamination of foods by radiostrontium. ^{89}Sr was applied to bean and corn plants, and chloranilic, tartaric, malic, and oxalic acids were sprayed on the above-ground parts of the plants. In the first experiment, after bean plants were cultured for 10 days, a culture solution (1 liter) containing 8 μC of ^{89}Sr was applied to each plant for 55 hr. Solutions containing 0.05% of the acids were sprayed to the above-ground parts twice a day for 7 days. Seeds of corn (White Dent variety) were germinated, and after culturing for 14 days, the plants were treated similarly to the beans. The above-ground parts of the plants were fractionated to water-soluble and insoluble fractions. Aliquots of the plant were homogenized with water, filtered, and ashed. Radioactivity of filtrate and residue was determined. Results showed that after spray application of the acids to bean and corn plants, more strontium was accumulated in the older leaves, and its transport to the younger leaves was inhibited. It is suggested that strontium in the plant tissue combines with these organic substances, and the resulting insoluble compounds (strontium chloranilate, strontium malate, and strontium oxalate) are precipitated in the plant tissue; accordingly, the transport of strontium to the upper parts is inhibited. (TCO)

26622 TOXICITY OF N-ETHYLMALEIMIDE AND DI-t-BUTYL NITROXIDE RADIOSENSITIZERS TOWARDS HeLa S3 CELLS IN A SINGLE CELL CULTURE. Klimek, Miros (Czechoslovak Academy of Sciences, Brno). Nature, 209: 1256-7(Mar. 19, 1966).

Results of studies on the toxic effects of N-ethylmaleimide (NEM) and di-t-butyl nitroxide (DTBN) on cultured HeLa cells showed that NEM had no effects on the reproductive ability of HeLa cells at concentrations lower than 3μM, while at concentrations of 10μM, 85% of the cells lost their reproductive ability and a concentration of 100 μM caused reproductive death of the entire population. A 40-min exposure to a 5 μM concentration DTBN had no effect on the reproductive ability of the cells, a concentration of 10 μM caused only 68% of the cells to lose their reproductive ability. The presence of DTBN in the medium for 11 days did not lead to increased toxicity. (C.H.)

26623 RESOLVING MIXTURES OF BETA EMITTERS IN PLANTS AND ANIMALS. Smith, Lawrence H. (Univ. of Minnesota, St. Paul). Nucleonics, 24: No. 4, 60-3(Apr. 1966).

A method was developed that uses planchet-counting techniques and is based on determining differences in the energy distribution of the beta particles emitted by different radionuclides for the quantitative assay of minute amounts of single beta-emitting tracers or mixtures of several tracers in plants and animals. The material and methods used are described, and the counting of particular radioisotopes in the presence of other radioisotopes is discussed. (J.F.P.)

26624 TECHNIQUE OF ADMINISTRATION OF LIQUID RADIOACTIVE AEROSOLS TO THE RESPIRATORY TRACT OF AN APE. Thieblemont, P.; Marble, G.; Perrault, G.; Pasquier, Ch. (Centre d'Etudes Nucleaires Fontenay-aux-Roses, France). Phys. Med. Biol., 11: 307-12(1966). (In French).

A technique is described of administering liquid radioactive aerosols of homogeneous activity to an ape through the respiratory tract; direct contamination of the alimentary tract is thus avoided. The technique enables the inhaled and the exhaled activity to be directly evaluated, thus permitting the determination of the activity actually retained in the air-passages of the animal. The apparatus used reduces the risks to which the experimenters are subjected. (auth)

26625 EFFECT OF VARIOUS ANIONS ON THE TRANSPORT OF STRONTIUM WITHIN PLANTS. Sakaguchi, Takashi (Miyazaki Univ., Japan). Plant Cell Physiol. (Tokyo), 6: 581-5(Dec. 1965).

Studies were made on the prevention of crop contamination with radiostrontium by arresting of the absorption of strontium in the roots, its transport to the upper organs being suppressed. An attempt was thus made to prevent the movement of strontium in plants by the use of anions capable of forming an insoluble salt with it. Silicate and phosphate ions were found to suppress considerably the transport of strontium in the plants tested. Pea and bean plants were pretreated with silicate, phosphate, and nitrate ions, and the distribution of strontium in various parts of the plants was examined. After pretreatment with silicate or phosphate ions, strontium absorption by the plant was decreased even if these anions were absent in the culture solution at the time of application of ^{85}Sr. The absorption of strontium by the plants pretreated with nitrate ions was similar to that of the controls. Strontium absorbed by the plants pretreated with silicate or phosphate was found to be accumulated in the roots and the quantity transported to the above-ground parts was small; especially with silicate, measurable amounts of strontium were not transported to the upper parts of the plant. In the control and nitrate-pretreated plants, strontium absorbed in the roots was readily transported to the above-ground parts. (BBB)

26626 ^{210}Pb AND ^{210}Po IN BIOLOGICAL SAMPLES FROM ALASKA. Beasley, Thomas M.; Palmer, Harvey E. (Battelle-Northwest, Richland, Wash.). Science, 152: 1062-4(May 20, 1966). (BNWL-SA-493).

The content of naturally occurring ^{210}Pb and ^{210}Po in samples of lichens, fish, and seal, bear, and caribou meats, and other biological samples collected in Alaska was found to be unusually high. The effect of the content of these radioisotopes in food on the content of radioactivity in Alaskan natives is discussed. (C.H.)

26627 STUDY OF THE ABSORPTION OF RADIOACTIVE FISSION PRODUCTS BY FIELD CROPS. II. ACCUMULATION OF RADIOACTIVE FISSION PRODUCTS BY GRAIN-LEGUMINOUS MIXTURES AND PERENNIAL GRASSES. Il'ina, G. V.; Rydkii, S. G. Vestn. Moskov. Univ., Ser. VI, Biol., Pochvoved., 20: No. 2, 3-9(1965). (In Russian).

The uptake of ^{90}Sr and ^{90}Y by pea, blue lupine, vetch, millet, and grasses was studied. Leguminous crops accumulated more radioactive fission products than grain crops. Lupine accumulated the maximum content per unit of dry weight. In comparison with the amount introduced into the soil, the amount of radioactive fission products removed with the harvest of grain-leguminous plants and perennial grasses was small. The introduction of a radioactive solution into the soil led to a reduction in the harvest of the majority of grain-leguminous crops and perennial grasses. The introduction of lime into the soil reduced the entry of radioactive substances (^{90}Sr) into the lucerne plants. (C.H.)

26628 ASSIMILATION OF RADIOSTRONTIUM FROM SOME FOOD PRODUCTS AND FROM A WATER SOLUTION OF STRONTIUM NITRATE DURING ITS PROTRACTED INTAKE BY RATS. Dobryakova, G. V. Vop. Pitaniya, 24: No. 6, 67-9(1965). (In Russian).

No differences in assimilation of ^{90}Sr were observed when rats were fed oats grown in ^{90}Sr-medium, milk from cows injected with ^{90}Sr, meat from sheep fed ^{90}Sr, or a water solution of ^{90}Sr nitrate. After 22 daily doses of 1.5×10^{-8} C of ^{90}Sr the bones of 5-week-old rats contained twice as much ^{90}Sr as bones of 3-month-old rats and 4 times as much as 6-month-old rats. (C.H.)

26629 THE DISTRIBUTION AND EXCRETION OF ^{90}Sr IN ALBINO RATS. Ch'eng, Lung-sheng; Cheng, Johsuan; Wang, Pao-hsin. Yuan Tzu Neng, No. 2, 144-9 (1965).

It was previously shown that radioactive isotopes of strontium, when administered to animals, accumulate chiefly in the bones and can cause serious radiation damage, such as bone cancers or even death. The removal of such materials from the body is therefore an urgent problem at the present time. This paper reports on the transportation, distribution and excretion of ^{90}Sr in albino rats observed at various periods following the intraperitoneal injection of ^{90}Sr. The amount of ^{90}Sr was determined by physical measurements as well as by autoradiography. Experimental studies showed that, after the injection of ^{90}Sr, radioactive material rapidly entered the blood stream and was thus distributed in various tissues. From these soft tissues, ^{90}Sr was transported fairly rapidly to the osseous tissues (including the teeth), where it became firmly lodged. Within seven days, the elimination of ^{90}Sr in the feces (56.08% of the total excretion) was already found to be in excess of that found in the urine (43.92%). The distribution of ^{90}Sr in the bones and other tissues was determined by autoradiography. (ATD)

26630 BIOCHEMICAL BASIS OF ORGAN AND TISSUE SPECIFICITY. Blau, Monte (Roswell Park Memorial Inst., Buffalo). pp 113-18 of CONF-651111.

Biological and biochemical mechanisms responsible for the organ localization of scanning agents are reviewed briefly. Distribution according to particle size, compartmental restriction, excretion and detoxification, abnormal permeability, sulfhydryl binding, and metabolic involvement of small ions and molecules was exploited. A list of several selected examples of scanning agent-target organ combinations is given. (P.C.H.)

26631 LABELED DRUGS IN EXPERIMENTAL PHARMACOLOGY. Roth, Lloyd J. (Univ. of Chicago). pp 119-28 of CONF-651111.

The metabolism and stereospecificity of labeled drugs used in pharmacology are discussed. Autoradiography of labeled drugs is used to investigate the blood brain barrier and to study the pattern of entry and accumulation of drugs in brain foci. A method designed specifically for autoradiography of soluble compounds on the dry mounting of freeze-dried frozen sections is described. (P.C.H.)

26632 ACTIONS OF MERCURIALS ON CELLS. Rothstein, Aser (Univ. of Rochester, N. Y.). pp 383-97 of CONF-651111.

The distribution of functionally important sulfhydryl groups in the cell and the factors that determine the accessibility of such groups to various mercurials are discussed. The mercurials can interact with a large proportion of the sulfhydryl groups of cellular proteins and can thereby potentially interfere with almost all cellular functions. In the intact cells, however, the actual effects of the mercurials are determined by the distribution and accessibility of various sensitive sites and by the rate of penetration of the agent into the cell. In isolated cells the penetration of interstitial spaces is not a factor. Inorganic mercury, as $HgCl_2$, penetrates rapidly into yeast and red blood cells, inhibiting a variety of functions. A large proportion of the mercury is, however, soaked up by insensitive sites within the cell, such as sulfhydryl groups of hemoglobin in the red cell, and thus the sensitive sites are protected. Organic mercurials do not penetrate the cell membrane nearly so rapidly as does inorganic mercury. Consequently, a complex sequence of events is observed. (P.C.H.)

26633 METABOLISM OF ^{75}Se L-SELENOMETHIONINE. Blau, Monte; Holland, James F. (Roswell Park

Memorial Inst., Buffalo). pp 423-8 of CONF-651111.

L-Methionine and its gamma-emitting analogue ^{75}Se L-selenomethionine were found to behave quite similarly in some systems including those for synthesis of the blood proteins and digestive enzymes and for active transport across the intestinal wall. On the other hand, in protein nutrition studies, ^{75}Se L-selenomethionine appeared to be metabolized quite separately from L-methionine. When ^{75}Se L-selenomethione is used as a substitute for methionine in any experiment, the equivalence of the two compounds must first be established. (auth)

26634 PROBLEMS OF CHROMIUM REACTIONS. Rollinson, Carl L. (Univ. of Maryland, College Park). pp 429-46 of CONF-651111.

Possible reactions of chromium(III) with substances present in biological systems are discussed. The probable behavior of Cr(III) in the intestine is predicted, and the small absorption of Cr(III) from the intestine was determined. Dialysis with ^{51}Cr has been used to investigate the solubility of Cr(III) in reaction mixtures containing hydroxide and phosphate ion in the range of concentration of the intestine. Solubility is decreased by increasing the pH and by introducing fatty acid ions. It is increased by increasing the phosphate-ion concentration. Several of the substances found in the intestine act as coordinating agents and thus increase solubility. At 37°C, rates of olation and accompanying processes are quite low but not negligible. Consequently, changes generally continue to occur during dialysis as well as during the time interval between the preparation of reaction mixtures and the start of dialysis. Reproducibility of results thus requires the standardizing of this interval. (49 references). (P.C.H.)

26635 COLLOIDAL PROPERTIES OF THE LANTHANIDES. Kyker, Granvil C.; Rafter, John J. (Oak Ridge Inst. of Nuclear Studies, Tenn.). pp 503-24 of CONF-651111.

Measurements in animals are presented which illustrate colloidal properties and project certain biomedical applications of various radioisotopic preparations of the lanthanides. Selected chemical properties that determine the colloidal behavior of these elements in biological systems, and the patterns of behavior reported for several widely differing colloidal systems that have been studied in animals are summarized. Various examples of experimental results are presented to illustrate the pattern of colloidal behavior for lanthanides in mammalian systems. These examples include studies with radioisotopic tracers of yttrium, cerium, gadolinium, dysprosium, holmium, and lutetium by intravenous and various interstitial routes of administration. Immobilization of these elements increases with dose and is essentially complete at or above levels of 10^{-7} moles/kg. Citrated hydrous oxide sols of cerium, gadolinium, or dysprosium prepared under specific empirical conditions show localization in bone marrow that favors evaluation for clinical use. In this respect wide variations occurred in comparing several species of experimental animals; rabbits served best for predicting clinical results. (auth)

26636 ISOTOPES OF CALCIUM AND STRONTIUM FOR STUDIES OF BONE METABOLISM IN MAN. Bauer, Goeran C. H. (Cornell Univ. Medical Coll., New York). pp 593-602 of CONF-651111.

Studies on metabolism of calcium and strontium isotopes in human bone for diagnosis of disease and for research purposes are discussed. The use of these isotopes is determined by its physical properties. Enriched, stable isotopes of Ca are detected by neutron activation analysis of material obtained from biopsy or collection of excreta. The gamma-emitting radioisotopes are used for whole-body counting and for regional assay. (P.C.H.)

Radiation Effects on Biochemicals

See also CHEMISTRY — Radiation Chemistry

26637 (CEA-R-2949) ETUDE DE LA CINETIQUE DE LA TRANSFORMATION FIBRINOGENE-FIBRINE ET MODIFICATIONS APPORTEES DANS CETTE REACTION PAR IRRADIATION (RAYONS X) DE SOLUTION DE FIBRINOGENE. (Study of the Fibrinogen–Fibrin Transformation Kinetics and Modifications Caused to this Reaction by Irradiation (X Rays) of the Fibrinogen Solution). Hollard, Daniel; Suscillon, Michel; Marcille, Genevieve; Rambaud, Francoise; Baloyan, Marie (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Feb. 1966. 10p. Dep. mn.

A spectrophotometric method is presented for studying the transformation of fibrinogen into fibrin. This method has the advantage of presenting immediately in graph form the three phases of this transformation, namely proteolyse or monomerisation, polymerisation, and clot stabilization. Modifications of this transformation due to x irradiation of fibrinogen solution were studied. Low doses (90,000 R/mm) prevented transverse polymerisation and doses of 180,000 R and more affected the action of thrombin on fibrinogen and did not give an organised clot, but a fragile gel. (tr-auth)

26638 (ISS-65/45) SPETTRO D'AZIONE PER L'EFFETTO PRODOTTO DALLA RADIAZIONE ULTRAVIOLETTA SUL DNA DEL FAGO α IRRADIATO "IN VITRO." (Action Spectra of the Effect of Ultraviolet Radiation on "In Vitro" DNA of Phage α). Cremonese, M. (Istituto Superiore di Sanitá, Rome (Italy). Laboratori di Fisica). Nov. 17, 1965. 37p. Dep. mn.

Action spectra of the effect of ultraviolet radiation on the physico-chemical properties of the DNA of phage α irradiated in vitro were obtained. Using the analytical ultracentrifuge and the spectrophotometer the following effects were studied: a) production of interruptions in the single polynucleotide strand; b) local denaturation; c) presence of a fraction of molecules resistant to denaturation; d) increase in the buoyant density of irradiated DNA. All of the action spectra thus obtained show a slight variation of the radiation efficiency in the range between 2600 and 2800 Å, and a well-defined peak at $\lambda \simeq 2880$ Å. Threshold values for all of the examined effects are 3000 Å. (auth)

26639 EFFECTS OF RADIOACTIVITY ON THE BIOLOGIC ACTIVITY OF CRYSTALLINE INSULIN AND PLASMA INSULIN. Pellegrini, G.; Maggi, G.; Rodari, T.; Specchia, G.; Fratino, P.; Tirella, G.; Zambaldi, G. (Univ., Pavia). Boll. Soc. Ital. Biol. Sper., 41: 1335-8 (Dec. 31, 1965). (In Italian).

Radioinactivation of crystalline porcine insulin, dissolved in buffer or plasma, by ^{131}I was examined using three biologic assays. The insulin was dissolved in 0.11M, pH 7 phosphate buffer and incubated at 4°C for tests at 24, 48, 72, and 96 hr. Plasma (in which the insulin had been inactivated by alkali) was added to the buffer in a ratio of 29 ml plasma per ml buffer. In some experiments K^{131}I had been added to the plasma to give a sp act. of 0.03 mC/ml. Most rapid radioinactivation of insulin was noted in rat diaphragm assay in which 100% of the activity was lost within 24 hr incubation. Less rapid loss of activity was noted with the glucose assimilation test in rats, and least rapid loss in an immunologic test. (BBB)

26640 SIGNIFICANCE OF DETERMINATION OF INSULIN BY THE RADIOIMMUNOLOGIC METHOD. Pellegrini, G.; Maggi, G.; Rodari, T.; Fratino, P.; Tirella, G.; Foschi, G. C. (Univ., Pavia). Boll. Soc. Ital. Biol. Sper., 41: 1345-7 (Dec. 31, 1965). (In Italian).

The effect of radioinactivation on immunologic assays using ^{131}I-insulin was studied. Incubation of insulin with its specific antibody for 24 hr in the presence of ^{131}I resulted in a loss of antigen-combining capacity of the antibody. Insulin itself also underwent loss of biologic activity as assayed by its hypoglycemic action in rabbits, convulsant activity in mice, and its ability to stimulate glucose utilization in several in vitro tests. Differences were demonstrated between crystalline porcine insulin and insulin extracted from porcine plasma in the interaction with complexes of ^{131}I-insulin and antibody. Crystalline porcine insulin, but not insulin from porcine serum displaced ^{131}I-labeled porcine insulin from preformed antigen-antibody complexes. (BBB)

26641 CONCERNING THE STATE OF DESOXYRIBONUCLEIC PROTEIN ISOLATED FROM THE SPLEEN TISSUE OF MICE AFTER THEIR IRRADIATION WITH GAMMA RAYS IN DOSES WITH A HIGH LEUKEMOGENIC EFFECT. Grigorovich, N. A. (Inst. of Experimental Pathology and Therapy, Academy of Medical Sciences, Sukhumi, USSR). Byull. Eksp. Biol. Med., 60: 106-9(Aug. 1965).

The molecular structure of desoxyribonucleic acid (DNA) obtained from spleen cells of albino mice subjected to gamma irradiation in doses producing the highest leukemogenic effect was studied. Two hundred mice were used in the two series of experiments. In the first series the animals were irradiated with gamma-rays in doses of 400 R; in the second series, with gamma rays in doses of 600 R. The DNA was isolated from the mice immediately, 24 hrs, and 5, 10, 20, and 30 days after irradiation. The mice were decapitated; the livers were excised and cooled at 0°C. The Spitkovskiy method was used to determine the condition of DNA and its molecular structure. Filament deformation indicating disturbed molecular structure of DNA was found within 24 hours and at later periods after the irradiation. This is probably due to the increase in the number of hydrogen bonds between the chains of desoxyribonucleic acid and histone, with the result that the configuration elasticity of the DNA macromolecule and, therefore, the magnitude of the highly elastic deformation of the filaments is increased. It is possible that these modifications are a direct result of the effect of radiation on the nucleoprotein. (CFSTI)

26642 INFLUENCE OF IONIZING RADIATION ON THE NUCLEIC ACID CONTENT OF LIVER MITOCHONDRIA IN RATS. Rudakov, V. V.; Korotkii, V. M. (Kirov Academy of Military Medicine, Leningrad). Byull. Eksp. Biol. Med., 61: No. 1, 51-2(Jan. 1966). (In Russian).

The influence of high doses of ionizing radiation (1,500 to 2,000 R) on the RNA content of liver mitochondria was studied in albino rats. Mitochondria were isolated two hours post irradiation. A significant increase (88% average) in mitochondrial RNA was observed in irradiated animals in comparison to non-irradiated controls. (H.G.D.)

26643 STABILITY OF THE COMPENSATORY MECHANISMS OF THE NERVOUS SYSTEM IN ACUTE RADIATION SICKNESS (MODEL OF UNILATERAL LABYRINTHECTOMY). Galichii, V. A. Byull. Eksp. Biol. Med., 61: No. 3, 48-51 (Mar. 1966). (In Russian).

A model of unilateral labyrinthectomy was used to show the influence of ionizing radiation on the compensatory processes occurring in the nervous system by estimating the reactions of postrotational nystagmus in rabbits rotated in both directions. The compensatory reactions were studied 4 to 5 hours after irradiation and then on the 3rd, 5th, and 8th day. The compensatory processes taking place in the nervous system were found to have great stability in all the periods of radiation sickness, which is apparently due to the stability of the nervous mechanisms of the brain stem. (auth)

26644 THE TRANSFER OF LEAF-RUST RESISTANCE FROM AGROPYRON TO TRITICUM BY IRRADIATION. Sharma, D.; Knott, D. R. (Univ. of Saskatchewan, Saskatoon). Can. J. Genet. Cytol., 8: 137-43(Mar. 1966).

The leaf-rust resistance of Agrus, a wheat-like Agropyron elongatum derivative, was found to be due to a gene (or genes) on an Agropyron chromosome. X rays and thermal neutrons were used to translocate a segment of this chromosome to a wheat chromosome. Four translocations involving the gene for leaf-rust resistance were obtained. One, located on chromosome 7D (XXI), appears to have no detrimental effect on plants and is transmitted normally through the gametes. (auth)

26645 MECHANISM OF IRRADIATED PROTEIN RADICAL RECOMBINATION IN THE PRESENCE OF OXYGEN. Sapezhinskii, I. I.; Emanuel', N. M. (Inst. of Chemical Physics, Academy of Sciences, SSSR). Dokl. Akad. Nauk SSSR, 165: 845-7(Dec. 1, 1965). (In Russian).

Oxygen consumption of irradiated proteins and loss of radicals were investigated in casein and bovine serum albumin to test the hypothesis that irradiated protein radical recombination takes place according to an oxidative recombination chain reaction. The initial number of radicals and the kinetics of their loss were measured by microwave spectrometer. Oxygen consumption was measured by a capillary microrespirator. Measurements were made over a 24-hr period to determine total oxygen consumption and radical losses. The proteins were gamma-irradiated (GUT-60-400, 20 to 50 Mrads doses) in a sealed microrespirator. It is evident that with the entry of oxygen into the system, the number of radicals is reduced and oxygen is consumed. The rates of these processes are highest at the beginning and gradually decrease. Total time for radical losses and oxygen consumption was 15 to 20 hr, with the quantity of oxygen consumed greater than the number of radicals recombined during the same period. On the basis of these data "chain length" may be calculated. The present data indicate that irradiated protein radical recombination in the presence of oxygen can take place according to an oxidative recombination chain mechanism. (ATD)

26646 INACTIVATION OF TRANSFORMING DNA BY ULTRAVIOLET IRRADIATION. Munakata, Nobuo; Saito, Hiuga; Ikeda, Yonosuke (Tokyo Univ.). Mutat. Res., 3: 93-100(Apr. 1966).

Transforming activities of various markers of Bacillus subtilis were inactivated by uv irradiation to different degrees. The results were compared with the studies on the differential inactivation by heat denaturation and on the fractionation on a methylated albumin column, which suggested that these markers might reside on DNA molecules of different base compositions. The markers on GC-rich DNA molecules seemed to be more resistant to uv inactivation and vice versa. This conclusion was supported by comparing the photoreactivable sectors of two markers showing different uv sensitivities. Experimental results also indicated a correlation between the uv resistance and the frequency of transformation. It seems likely that the base composition in the marker region might be an important factor causing the difference in transformation frequency and that the uv irradiation might exaggerate the difference. In contrast, x rays inactivated all the activities at almost similar rates. Minor differences might have been caused by certain indirect effects. (auth)

26647 FUNCTION OF NUCLEIC ACIDS IN PROCESSES INDUCED BY IONIZING RADIATION. Kuzin, A. M. Nowotwory, 16: 1-7(Jan.-Mar. 1966). (In Polish).

The functions of DNA and RNA in the development of radiation injuries in cultured HeLa cells were studied at the molecular level. It is postulated that messenger RNA is involved in the transfer of metabolic information during various stages of development of the cell. Factors affecting the radiosensitivity of DNA transduction are discussed. (C.H.)

26648 APPARENT ESR PHOTOSIGNALS IN MELANIN. Zahlan, A. B.; Maling, J. E.; Blois, M. S. (Stanford Univ., Calif.). Photochem. Photobiol., 5: 269-70(Mar. 1966).

A study of the effect of uv radiation on electron spin resonance (ESR) in squid melanin showed, under certain conditions, an apparent photo-enhancement of the melanin resonance. Both synthetic and natural melanins are known to have an ESR due to a free radical trapped in the melanin polymer. The characteristic signal is a single line from 4 to 8 G wide which is slightly asymmetric and which has a g-value between 2.003 and 2.004. The samples examined in these experiments were: pure squid melanin, copper-doped melanin, and HCl-digested melanin. In all cases where the effect was observed the normal ESR was saturated and the photo-enhanced ESR was found to have a T_1 shorter than that of the normal ESR. T_1 was measured by the saturation method. Photo-enhancement became increasingly less effective as the r-f power level was lowered. In the case of HCl digested melanin the effect was investigated into the microwatt region of power and it was found to almost disappear. Where the ratio of photo-amplitude to dark-amplitude was plotted as a function of r-f power, the curve could be extrapolated to a ratio below 5 or 10 μw r-f power. It was concluded that the optical radiation causes a reduction in the saturation factor, that is, a reduc-

tion in spin-lattice relaxation time, resulting in an apparent photo-enhancement of ESR intensity in regions of r-f power where the signal is saturated. (BBB)

26649 COAGULABILITY OF THE BLOOD AND ITS FIBRINOLYTIC ACTIVITY IN ACUTE RADIATION SICKNESS. Baluda, V. P.; Lysogorov, N. V.; Khnychev, S. S.; Ishmukhametova, D. N.; Rukazenkova, Zh. N.; Gorlanova, T. A.; Rudakov, I. A.; Susanyan, T. A. (Inst. of Medical Radiology, Obninsk, SSSR). Vestn. Akad. Med. Nauk SSSR, 20: No. 9, 70-4(1965). (In Russian).

Acute radiation sickness was induced in rats by a single whole-body irradiation with ^{60}Co, 600 rads at 100 rads/sec. Bleeding occurred and the functional state of the coagulating and fibrinolytic systems of the blood was disturbed. Bleeding during acute radiation sickness set in by the 2nd day after irradiation. The resistance of the walls of the vessels of the skin was not substantially changed, but disturbance of the walls of the vessels of the gastrointestinal tract occurred and led to a loss of erythrocytes from the vascular bed into the intestinal lumen and, subsequently, to disturbances of the walls of the skin vessels. In this period, the coagulability of the blood was accelerated, while fibrinolysis was also increased. At the height of the acute radiation sickness, the coagulability of the blood began to fall, and fibrinolysis was reduced. In the 30-day period of recovery, the coagulability of the blood was somewhat accelerated, while fibrinolysis remained low. In acute radiation sickness, fibrinogen B appeared in the blood, the coagulability of the fibrinogen was retarded and the clots of fibrin became loose. The disturbance of the fibrin clot is apparently associated with the reduced activity of fibrinase, and the process of conversion of a fibrin polymer. (C.H.)

26650 CHANGES IN THE COMPOSITION OF THE SERUM PROTEINS OF ANIMALS INJURED BY IRRADIATION. Kashkin, K. P.; Aleksandrova, S. V. (Inst. of Medical Radiology, Obninsk, SSSR). Vestn. Akad. Med. Nauk SSSR, 20: No. 9, 93-6(1965). (In Russian).

Serum proteins of mice irradiated with x rays and of rats and monkeys irradiated with γ rays of ^{60}Co, were changed, as was demonstrated by immunoelectrophoresis utilizing high resolution rabbit antiserums in intact and irradiated animals. Antiserums to the serum of irradiated animals were not completely neutralized by adsorption with the corresponding serums of the intact animals. These antiserums were distinguished by increasing heterogeneity. Reduction of γ globulin content was a result of cell and of lymphoid tissue destruction. Albumin decrease followed a redistribution between the inner and outer vessel channels. Some α- and β-globulin fractions were increased, others were decreased. There were fractions with varying electrophoretic mobilities in the areas of transferrin and α_2-globulin. (C.H.)

Radiation Effects on Tissues

26651 (AD-632282) DIFFERENTIAL SENSITIVITY OF CIRCULATING AND PERITONEAL MONONUCLEAR CELLS OF MICE TO TOTAL-BODY X IRRADIATION. Kornfeld, L.; Greenman, V. (Naval Radiological Defense Lab., San Francisco, Calif.). Mar. 21, 1966. 22p. (USNRDL-TR-999). CFSTI $2.00 cy, $0.50 mn.

Dose-response curves obtained 1 and 3 days after exposure to total-body x irradiation indicate that the mononuclear cells in the circulating blood and in the peritoneal cavity of LAF_1 mice may be arranged in the following order of decreasing sensitivity: circulating lymphocytes, small peritoneal lymphocytes, medium peritoneal lymphocytes, and peritoneal macrophages. However, on the 3rd day postirradiation, the curve of the small peritoneal lymphocytes closely approached that of the circulating lymphocytes. It is suggested that the greater sensitivity to irradiation of small rather than medium peritoneal lymphocytes is not due to environmental factors but to as yet unidentified differences in the cells. On the other hand, the greater loss of circulating lymphocytes rather than small peritoneal lymphocytes 1 day after x ray exposure may merely reflect more efficient removal of damaged cells from the circulation than from the peritoneal cavity. (auth)

26652 (AD-632540) EFFECTS OF IRRADIATION ON BONE GROWTH OF RATS DURING PROTRACTED PARABIOSIS. Carroll, H. W.; Phillips, R. D.; Kimeldorf, D. J. (Naval Radiological Defense Lab., San Francisco, Calif.). Apr. 5, 1966. 12p. (USNRDL-TR-1004). CFSTI $1.00 cy, $0.50 mn.

The effects of x irradiation on bone growth were studied in pairs of rats during protracted parabiosis involving vascular anastomosis. The preparation was used to define some potential mechanisms through which systemic factors contribute to growth retardation. No demonstrable deleterious effect of irradiation of one partner was sustained by the shielded partner in terms of bone growth. On the other hand, direct evidence was obtained to show that the bone growth deficit observed in the irradiated rat at 60 days postirradiation was reduced by shielding its parabion partner. The findings are consistent with the concept that the systemic effect on bone growth is a result of hormonal imbalance rather than the consequence of toxic factors produced by irradiation. (auth)

26653 (EUR-2634,d) ZUR DIAGNOSE VON STRAHLENSPAETSCHAEDEN DER HAEMOPOETISCHEN ORGANE INFOLGE BERUFLICH BEDINGTER CHRONISCHER STRAHLENBELASTUNG. (The Diagnosis of Delayed Radiation Damage to the Hematopoietic Organs Following Chronic Occupational Radiation Exposure). Wendt, F.; Preussler, A. (Freiburg Univ. (West Germany). Medizinische Klinik. Gesellschaft fuer Strahlenforschung m.b.H., Freiburg (West Germany). Institut fuer Haematologie). 1966. 100p. Dep. mn.

The effects of radiation on 13 occupationally exposed persons were investigated by means of information from the occupational hazard insurance companies and other sources. The cases were divided into 4 groups according to the degree of damage, namely: Minor reversible damage with temporarily lowered bone marrow cellularity and blood cell reductions (7 cases); medium reversible damage with longer term history of bone marrow hypoplasia and pathological blood cell values (1 case); severe irreversible damage with persistent bone marrow hypoplasia and pathological blood cell values (1 case); and malignant hemoblastosis or other forms of neoplastic bone marrow disease. The probability was established that the effect of radiation was an essential pathogenetic factor in 4 cases: a reticulosarcomatosis, a subacute myeloblastic leukemia, a subacute lymphatic leukemia, and a lymphatic leukemia with transition to a reticulosarcomatosis. No unequivocally radiation-specific alterations were found. The diagnosis of radiation-induced damage to the hematopoietic organs from small radiation doses, such as occur in occupational exposure, can be made with adequate probability only after detailed and comprehensive investigation, and only from the totality of all unspecific symptoms. In this context a special significance is attached to exposure anamnesis, the subjective data of which must be supplemented by as accurate an individual dosimetry as possible. (auth)

26654 (JUL-313-20) UNTERSUCHUNGEN UEBER DIE WIRKUNG VON ROENTGENSTRAHLEN AUF DEN HUEHNEREMBRYO. (Investigations on the Effect of X Radiation on Chicken Embryos). Wendt, Ernst (Kernforschungsanlage, Juelich (West Germany)). Oct. 1965. 89p. Dep. mn.

The lethal dose of x radiation for chick embryo heart cells in tissue culture was found to be 3,500 R. Morphological changes observed in heart cells from 4 to 20 day embryos following exposure to radiation doses of 600 to 3,000 R are described in detail. Tissue culture methods are discussed. (C.H.)

26655 (NP-15975) ANNUAL REPORT NO. 15 [ON GENETICS], 1964. (National Inst. of Genetics, Mishima (Japan)). 1965. 166p. Dep. mn.

Data are summarized from genetic studies on animals, bacteria, higher plants, and human populations. Emphasis

was placed on studies on Escherichia coli and Salmonella, Drosophila, silkworms, cereal plants such as rice and wheat, tobacco, fruit trees, forest trees, poultry, and a Japanese population of 2,500 couples between the age of 30 and 40 years and approximately 6,000 children of the individuals studied. Data are included from studies on the mechanisms of chromosomal abnormalities induced by chemical mutagens and γ, x, or neutron radiations and related biochemical and cytological studies. A list is included of 86 publications during 1964. (C.H.)

26656 (NYO-3361-6) PROGRESS REPORT [ON EFFECTS OF TOTAL-BODY IRRADIATION ON LIVER MITOCHONDRIA OF RATS], MARCH 1, 1965–MAY 31, 1966. Bahr, Gunter F. (Georgetown Univ., Washington, D. C.). Contract AT(30-1)-3361. 11p. ORAU.

Electron microscopic, fluorescence microscopic, and cytochemical techniques were used to study the effects of whole-body exposure of rats on individual liver mitochondria. Exposure of rats to 1000 R in 4 min caused a rapid rise in dry mass of individual mitochondria that reached 30% above normal 6 hr postirradiation and returned to normal values after 24 hr. Concomitantly mitochondrial volume increased rapidly during the first 3 hr postirradiation. Preliminary results are reported from studies of the effects of liver shielding on the response of liver mitochondria to radiation and the effects of radiation on mitochondrial DNA. (C.H.)

26657 (SRIA-115P53-1) AN INVESTIGATION OF ACUTE SUBTLE EFFECTS OF MODERATE TO LOW DOSES OF RADIATION ON SYNAPTIC MECHANISMS. Final Report, January 1, 1965–January 31, 1966. Carregal, Enrique J. A. (Stanford Research Inst., Menlo Park, Calif.). Contract AT(04-3)-115. 24p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

Cats were either x irradiated by whole-body exposure or were completely protected by a lead shield two inches thick, except for a hole, 1 cm in dia., directly over the exposed portion of the spinal cord. Dose rates used in the irradiations were in the range 7–350 R per min. On the basis of the results obtained, it was concluded that irradiation, within the dose range of 7 to 22,000 R, does somewhat affect the functions of the different components of the spinal monosynaptic arcs. However, some of the effects, even at the highest doses of radiation used, were so small that it is questionable whether they have any meaning in the performance capacity of the intact animal. The most significant findings were the changes occurring in the thresholds of both the pre- and postsynaptic elements of the monosynaptic reflex. (P.C.H.)

26658 (JPRS-35011) ACUTE RADIATION ILLNESS AND DOSAGE DETERMINATION. Kurshakov, N. A. Translation of pp 3; 5-45 from Ostraya Radiatsionnaya Travma u Cheloveka, Moscow, 1965. 36p. (TT-66-31449). CFSTI $2.00 cy, $0.50 mn.

Separate abstracts were prepared on two articles included in this translation from the Russian language book. (C.H.)

For abstracts of individual papers see: 26659 and 26660.

26659 (JPRS-35011, pp 2-24) THE PATHOGENESIS AND GENERAL CLINICAL CHARACTERISTICS OF ACUTE RADIATION ILLNESS. Kurshakov, N. A. Translation of pp 5-34 from Ostraya Radiatsionnaya Travma u Cheloveka, Moscow, 1965.

The pathology of radiation sickness in man is reviewed. Symptoms observed during the initial period, latent reactions, manifest clinical signs, and the period of recovery are described in detail. (C.H.)

26660 (JPRS-35011, pp 25-35) DETERMINATION OF ABSORBED DOSES. Drutman, R. D.; Malysheva, M. S.; Shtukkenberg, Yu. M. Translation of pp 35-45 from Ostraya Radiatsionnaya Travma u Cheloveka, Moscow, 1965.

A woman scientific worker entered a room where experimental samples were being exposed to a ^{60}Co γ source. She withdrew the samples from a Dewar flask in the center of the source, which consisted of 48 ^{60}Co rods 80 mm in height and 9 mm in diameter situated uniformly along a cylindrical surface within a stainless steel cassette. The total activity of the ^{60}Co source amounted to 36 kg equivalents of Ra. A phantom was used for calculations of the absorbed doses to the head, body, arms, hands, and legs. Procedures used for calculations of the absorbed dose are described. The dose to vitally important organs of the body and bone marrow was estimated to range from 450 to 600 rads. (C.H.)

26661 (ORNL-tr-1234) PRELIMINARY COMPLEMENTATION MAP OF THE AD_2 LOCUS IN THE YEAST SACCHAROMYCES CEREVISIAE. Soidla, T. R. Translated for Oak Ridge National Lab., Tenn., from Genetika, No. 3, 127-31(1965). 8p. Dep. mn. CFSTI $1.00 cy, $0.50 mn. JCL $1.10 fs, $0.80 mf.

Results are reported from a study of interallelic complementation in 170 mutants at the ad_2 locus obtained by exposure of Saccharomyces cerevisiae to x or uv radiation or treatment with nitrous acid. Each mutant to be tested for complementation was crossed with prototrophic strains. A preliminary complementation map of the ad_2 locus in this yeast is presented. (C.H.)

26662 EFFECT OF IRRADIATION ON FINE STRUCTURE AND ENZYMES OF DOG PANCREAS. I. SHORT-TERM STUDIES. Volk, Bruno W.; Wellmann, Klaus F.; Lewitan, Alexander (Isaac Albert Research Inst., Brooklyn. Jewish Chronic Disease Hospital, Brooklyn). Amer. J. Pathol., 48: 721-53(May 1966).

The effect of ionizing radiation has particular interest since the pancreas actually consists of two organs, an exocrine portion and the islets which, histologically and functionally, are separate entities. A study was undertaken to investigate the effect of a single (5,000 to 9,000 R) dose of x rays on the fine structure and on several enzymes of the exteriorized pancreatic remnant in 23 dogs after partial pancreatectomy. These were examined at time intervals varying from 30 minutes to 21 days after treatment. Acinar cells exhibited large numbers of membrane-bound cytoplasmic lesions, with varied patterns. These contained altered cytoplasmic components as well as a variety of pleomorphic electron-dense structures consisting of osmiophilic agranular membranes, vacuoles and granules of varying size and shape. Maximum acinar cell damage was manifested 5 to 8 days after treatment. Between the 12th and 21st days the number of lesions was reduced, although various pleomorphic alterations were still evident. There was also a reduction in the number and size of mature zymogen granules which became more prominent with the lapse of time after treatment. Simultaneously the amount of pancreatic amylase, lipase and leucine aminopeptidase appeared lessened. Islets exhibited moderate degranulation, swelling of mitochondria, distention of endoplasmic reticulum and the appearance of dense bodies in a number of B cells. Several A cells displayed cystic dilatation of the endoplasmic reticulum, deposition of a finely granular intracytoplasmic material and swelling of mitochondria. In contrast to the acinar cells the alterations in islet cells became more conspicuous near the end of the experimental period. Despite the B cell changes daily blood sugar levels and glucose tolerance tests maintained normal values.(auth)

26663 EFFECT OF X-IRRADIATION ON THE OVIPOSITION OF THE TELEOST, ORYZIAS LATIPES. Egami, Nobuo; Hyodo, Yasuko (National Inst. of Radiology Sciences, Chiba, Japan). Annot. Zool. Jap., 38: 171-81 (Dec. 1965).

If kept together with a male, the Oryzias latipes female laid eggs almost every day during the breeding season. If such females were irradiated with 2KR of x rays, oviposition was inhibited during a period ranging from 1 to 3 weeks after irradiation. Irradiation was effective in this respect even if it was performed after the ovarian part of the body was shielded from the rays. Histological studies revealed that the temporary sterility was due to damage to growing oocytes at the yolk vesicle stage. Irradiation of females with large doses of x rays (4-32 KR) induced permanent sterility causing disintegration of oocytes at all stages of growth. (auth)

26664 HEMATOLOGICAL CHANGES IN RADIATION SICKNESS. VI. CHANGES IN THE BONE MARROW. Arient, M.; Dienstbier, Z.; Pospisil, J. (Zentralmilitaer-krankenhauses, Prague. Karls-Univ., Prague). Atompraxis, 12: 147-9(Mar. 1966). (In German).

Quantitative analysis of bone marrow cells furnishes information on the actual state of hematopoiesis during the course of radiation sickness. In contrast, evaluation of a relative myelogram can give only a general indication of the nature of the changes and in many cases provides erroneous information. Tests on rats showed that the absolute number of bone marrow cells changes in close relation to the radiation dose. The erythropoietic elements are more sensitive than the granulopoietic, but they also regenerate sooner and faster than the latter. The number of mononucleate cells is a good criterion for prognosis of radiation sickness. The multiplication of reticular cells after higher radiation doses is absolute, and not only relative. (auth)

26665 SURVIVAL AND REPRODUCTIVE ABILITY OF INFANTILE MALE RATS AFTER TOTAL-BODY SINGLE AND FRACTIONATED IRRADIATION WITH A X-RAY DOSE OF 800 r. Savkovic, N.; Hajdukovic, S. (Boris Kidrich Inst., Belgrade). Atompraxis, 12: 154-6 (Mar. 1966).

An x-ray dose of 800 R was fractionated as follows: 800 R/8 days and 800 R/8 weeks. Results showed that the survival is higher if the dose is fractionated. The longer the interval between fractions of irradiations the higher was the survival rate. Reproductive ability was significantly higher if the dose of 800 R was fractionated and given in weekly intervals, than if the same dose was given in day intervals. (auth)

26666 MITOTIC FREQUENCY IN ROOT TIPS OF HAPLOPAPPUS GRACILIS AFTER UV- AND X-IRRADIATION OF MATURE EMBRYOS. Nirula, Satya; Roebbelen, Gerhard (Univ., Goettingen, Ger.). Can. J. Genet. Cytol., 8: 1-7(Mar. 1966).

Mature embryos of Haplopappus gracilis from seeds soaked for 10 hours were exposed to single or combined uv and x irradiations in order to determine their influence on the mitotic frequency during the first cycle in the root tip meristem. With the doses applied, uv as well as x rays inhibited the entry of cells into mitosis. With x rays of 400 R an initial impair was followed by a compensatory rise of the mitotic frequency. The increase, however, was more than proportional to the earlier reduction, suggesting the presence of a second factor. The combined treatment revealed an opposite action of uv and x irradiation. An additional x ray dose reduced the drastic uv inhibition of mitosis to about 100%. The result was independent whether the x rays were applied immediately after the uv irradiation or 10 hours later, i.e., even during the early phases of mitosis. This rise of the mitotic frequency can be attributed to a general slowing down of the rate of progression of cells through mitosis. The study indicates that root tips of H. gracilis are valuable experimental material even for investigations on the mitotic effects of uv irradiations in meristems of higher plants. (auth)

26667 EFFECTS OF GAMMA-IRRADIATION ON THE POLLEN OF LILIUM REGALE. Loh, Pao-Min T.; Cooper, D. C. (Univ. of Wisconsin, Madison). Can. J. Genet. Cytol., 8: 152-64(Mar. 1966).

Gamma irradiated pollen of Lilium regale at 1, 2, 4, 8, and 10 kR was as capable of germination as the controls. The exposed number of dividing generative nuclei following increasing dosages was reduced from 98 to 11% of the controls, and 26 to 100% of the mitotic configurations possessed some type of aberrations. Chromatid breaks, isochromatid breaks, and fragments were the main aberrations. Occasionally gaps, incomplete breaks and interchanges occurred. The number of aberrant chromosomes per nucleus was closely correlated with the dosage. The percentages of aberrant chromosomes on the basis of total chromosomes were 2.19 to 28.09 following irradiation as compared with 0.28 in the controls. Chromatid breaks increased as dosages rose by increasing the number of chromosomes with 1 to 2 breaks. Isochromatid breaks increased with more chromosomes having more breaks. The ratios of isochromatid to chromatid breaks are larger at the higher dosages. Isochromatid breaks occurred most frequently on chromosomes of the subtelocentric type and usually near the proximal end of the arms. The number of fragments per 100 cells is not directly correlated with dosages. (auth)

26668 HEMORRHAGIC SYNDROME AFTER TOTAL-BODY EXPOSURE TO SMALL AND MEDIUM DOSES OF X RAYS. Svehla, C.; Konig, J.; Rysanek, K.; Spankova, H.; Mlejnkova, M. (Inst. for Postgraduate Medical Training, Prague). Cas. Lek. Cesk., 104: 1041-5(Sept. 24, 1965).

The most marked effects of x radiation exposure include the decrease in thrombocytes and capillary lesions. They seem independent, and due to toxic influences, rather than to immunological mechanisms. A drop in the prothrombin complex, an increase in antithrombin activity, and a tendency to hyperinosis appeared to be adjuvant factors. The plasmatic component of thromboplastin formation remained unchanged in the experiments reported. (CFSTI)

26669 ROLE OF AN OXYGEN-REPLACING GAS IN A QUANTITATIVE STUDY OF OXYGEN EFFECTS. Paribok, V. P.; Genter, E. I. (Inst. of Cytology, Academy of Sciences, SSSR). Dokl. Akad. Nauk SSSR, 165: 1416-18 (Dec. 21, 1965). (In Russian).

The effect of x-irradiation (50 r/min) on the growth of the main root of bean shoots (Vicia faba) was studied using gases in the medium, O_2 plus 1% N_2 and other inert gases, and specially purified N_2 and argon. The gaseous medium was introduced into the chamber 10 min prior to irradiation and the plants were removed 5 min following irradiation. Addition of N_2 or Ar to the oxygen decreased the damaging effects of irradiation in that the growth of bean shoots was much greater when these gases were added than when O_2 was solely present. Furthermore, this protective action only applies to the O_2-dependent part of radiation damage since the effect was absent in the absence of O_2 (in a vacuum). These experiments indicate that in studying the radiosensitizing effects of O_2 as a function of its concentration it is necessary to use other methods than the addition of inert gases to vary the O_2 concentration in the medium in forms such as plants and insects, in which the O_2 is carried to the cells via channels to narrow for the replacing gases. (ATD)

26670 EFFECT OF SMALL AMOUNTS OF THE CHINESE MAGNOLIA VINE ON CONDITIONED ORIENTING REFLEXES IN HEALTHY AND IRRADIATED DOGS. Voevodina, O. N.; Volkova, V. D. (Inst. of Experimental Medicine, Academy of Medical Sciences, USSR). Farmakol. Toksikol., No. 2, 135-7(Mar.–Apr. 1965).

Oral administration of powered Chinese magnolia vine (Schizanda chinensis) or seeds in amounts ranging from 10 to 100 mg/kg decreased the latent period of conditioned orienting reflexes in dogs, increased the rate of conditioned motor reflexes, and intensified general motor activity and salivation. A 500 mg/kg dose had the same effects, with some alteration of behavior during the intervals between presentation of the conditioned stimuli. In irradiated dogs, a 0.5 mg/kg dose improved the orienting reflexes, but increasing the dose to 1 to 100 mg/kg impaired the spatial conditioned reflexes, lengthened the latent period of the conditioned motor reflexes, disinhibited differentiation, and gave rise to inhibition. The degree of impairment of conditioned activity varied with the radiation dose, amount of Schizanda chinensis administered, and individual characteristics of the higher nervous activity of the individual animals. (CFSTI)

26671 SUBMICROSCOPIC CHANGES AND PROCESSES OF REGENERATION IN THE CNS AS A REACTION TO DIFFERENT INFLUENCES. Manina, A. A.; Kucherenko, R. P. (Inst. of Experimental Medicine, Leningrad). Folia Morphol., 13: 158-64(1965).

Electron microscopic studies were made of the cells of the CNS (central nervous system) following whole-body irradiation, hyperthermia, and hypoxemia. Immature, adult, pregnant, and newborn rats were irradiated with

180-kv x rays at 30 R/min. Other rats were exposed to external temperatures of 40 to 42°C for one to 6 hr, and a third group to N_2 containing 2.5% O_2. The different agents led to the same type reactive processes and lesions in the ultrastructure of cellular elements in the CNS. These effects were nonspecific in character, but the rate of their development and the extent depended on the severity and nature of the agent. The first stage was referred to as a state of irradiation. At this stage the reaction of the agent appeared as one of adaptation, consisting in the mobilization of various cellular mechanisms to overcome the damage. Marked structural changes and the rearrangement of ribonucleoprotein (RNP) granules in the nucleus of the neuron took place. After whole-body irradiation with 700 R, on the third day changes were seen indicating the transition from the stage of injury to that of regeneration of the damaged structures of the nerve cell. A lower exposure (200 R) reduced the transition from the stage of injury to the stage of regeneration by 24 hr. The gradual normalization of the damaged granular structure of RNP, as well as of the membraneous formations of the mitochondria and of the ergastoplasmic reticulum of the neuron could be observed. Early regeneration of the subcellular structures occurred simultaneously in the mitochondria and nucleus. Consequently, the process of regeneration of the subcellular structures of the nervous cell is inseparable from the earlier destructive changes. The duration and effect of regenerative subcellular processes depend on the relation between the extent and severity of the damage and the regenerative ability of the neuron. (BBB)

26672 POLYPLOIDIZATION AND ABERRATION OF HUMAN CHROMOSOMES INDUCED IN VITRO AND IN VIVO WITH IONIZING RADIATIONS. **Nasjleti, Carlos E. (Univ. of Michigan, Ann Arbor); Walden, James M.; Spencer, Herbert H. J. Nucl. Med., 7: 159-76(Mar. 1966).**

The occurrence of polyploidy and endoreduplication is increased in leukocytes following irradiation in vitro and in vivo. The occurrence of structural chromosomal abnormalities is again documented. The radiations of ^{131}I, ^{60}Co, and x rays have similar qualitative effects as measured by leukocyte cultures. Information as to how long chromosomal damage will persist after irradiation is not as yet available and in one individual who had received ^{131}I therapy shortly before these studies, no evidence of damage was seen. Recent literature on polyploidization of chromosomes is presented and discussed. (49 references.) (auth)

26673 TISSUE DESTRUCTION BY LASER ENERGY, ITS MANAGEMENT AND PREVENTION. **Minton, John Peter (Ohio State Univ. Hospitals, Columbus). J. Trauma, 6: 262-6(Mar. 1966).**

The potential traumatic injuries that can result from exposure to a high energy laser beam are described. Tissue destruction by long pulse and continuous wave-length lasers is dependent on: total amount of energy delivered to the tissue (J/cm^2); wavelength of the laser; absorption characteristics of the target tissue for the incident wavelength; and optical focus of the laser beam. The process of tissue destruction by the short-pulse laser (10^{-9} sec) is referred to in w/cm^2 and differs from that produced by either the long-pulse laser or the continuous wavelength laser. Tissue destruction by short-pulse laser is probably not wavelength dependent and is due in part to factors other than heat, such as ionization and acoustic wave coupling. The physical response of various tissues to the impact of a long laser pulse is dependent on the structural and pigmentation characteristics of the tissue itself. Prevention of laser injuries is discussed. Retinal damage is the most common type of injury. Not only visible wavelengths, but invisible ir and uv radiation, can destroy retinal tissue in a fraction of a second. When lasers with output energies of 20,000 to 100,000 J are developed, instantaneous critical injuries may occur. Depending on the impact energy, structures underlying the impact site may be damaged. Hollow viscera may rupture and solid viscera such as the liver, spleen, or kidney may be lacerated. The potential traumatic effects of higher energy laser beams are considerable. It is estimated that an energy output of 100,000 J is capable of producing a third-degree burn of 40 in. dia and an inestimable amount of internal tissue destruction. This amount of laser energy may be near the lethal threshold for humans. (TCO)

26674 ENDOTHELIUM MODIFICATIONS IN THE LYMPH VESSELS OF SEROUS MEMBRANES IN EXPERIMENTAL ACUTE RADIATION SICKNESS. **Mil'ko, V. I.; Chernyshenko, L. V. Klin. Khir., 44: No. 7, 67-71(July 1965).**

Albino rats were used in several series of experiments carried out to determine the effect of radiation sickness on the endothelium of the lymph capillaries of the serous membranes. The rats were exposed to x radiation in doses of 600 R. A 0.25 percent solution of silver nitrate was injected into the lymph capillaries. Lymph capillaries of the stomach, diaphragm, the anterior abdominal wall, the diaphragmatic pleura, and epicardium were examined during the different phases of radiation sickness. The examinations established that destructive modifications of the endothelium developed within a short time after radiation sickness was induced in the animals. Cell boundaries began to disappear, and the cell contours became indistinct. Lumps of decomposition developed in the nonargyrophilic cytoplasm. This condition became more aggravated as radiation sickness progressed, reaching its apex at the height of the disease. (CFSTI)

26675 EFFECT OF IONIZING RADIATION ON DISTENTION AND CONSTRICTION OF LIVER MITOCHONDRIA. **Yang, Fu-yu; Lin, Chih-huan; Li, Sheng-kuang. K'o Hsueh T'ung Pao, No. 9, 814-16(1964).**

The changes in distention and constriction of rat liver mitochondria resulting from x ray irradiation were studied. Mitochondria were suspended in a 0.30 M sucrose solution containing 0.02 M tris(hydroxymethyl)aminomethane buffer at pH 6.9 under a constant temperature (30°C) condition. X-ray treatment was administered at a dose of 20,000, 40,000 and 70,000 R. Test results revealed that the rate of mitochondrion distention is lower than the rate of the control group. The rate of mitochondrion distention can be increased by the addition of 6×10^{-3} M succinic acid to the solution. The addition of 1×10^{-5} M adrenaline exhibits the same effect as succinic acid. The rate of the mitochondrion constriction can be increased by the addition of adenosine triphosphate (ATP) after irradiation. The addition of ethylenediaminetetraacetic acid (EDTA) has the same effect as ATP if a sufficient amount of oxidant is present in the medium. The degree of cellular structure destruction caused by ionizing radiation does not change the permeability of nicotinamide adenine dinucleotide (NAD). Irradiation has a similar effect on mitochondria as senility. (ATD)

26676 THE ASSESSMENT OF CERTAIN CRITERIONS OF RADIOSENSITIVITY. **Gorizontov, P. D. Med. Radiol., 10: 3-10(Oct. 1965). (In Russian).**

Changes in the quantitative composition of bone marrow cells can be used to estimate radiation damage to the hematopoietic system. All groups of red cells including erythroblastic cells are damaged by ionizing radiation. Further studies should determine the dynamics in change of blood composition of various cell forms at various periods after the radiation. The mitotic index of hematopoietic cells is not suitable for estimating the effect of ionizing radiation on an organism because of the existence of compensating mechanisms which tend to reestablish the disturbed equilibrium. The counting of chromosomal aberrations at early anaphase and late telophase is a measure of radiation damage. The number of aberrations is directly proportional to the dose. The levels of serotin and histamine in the blood can serve as indicators of radioresistance, but further study is required in this field. It is pointed out that the enucleated eyes of frogs are sensitive to gamma doses of 0.001 to 0.015 r/sec, and that a local dose of 1000 to 3000 R is necessary to disrupt this reaction. Hence it is essential to distinguish between radiosensitivity and radioresistance. (TTT)

26677 INDIRECT EFFECT OF HISTAMINE FORMATION IN RADIATION SICKNESS. **Bilushi, S. G.; Goncharenko, E. N.; Kudryashov, Yu. B. Med. Radiol., 10: 55-6 (Oct. 1965). (In Russian).**

White male rats and rabbits were given a whole-body

dose of 800 rads x ray. Histamine content in the skin, kidneys, and liver was determined 1 hr and 3 days after the irradiation. It was found that an intraperitoneal injection of 0.7 to 0.9 g of toxic lipid material caused similar fluctuations in the histamine content of these tissues. At first the histamine level is increased, and then is decreased below the normal value. It is believed that the oxidation products of unsaturated fatty acids showed a radiomimetic effect. It is thought that ionizing radiation caused the formation of active oxidation products of unsaturated fatty acids which led to the accumulation of the biologically active substance histamine by suppressing the histaminase activity of the tissues. (TTT)

26678 MUTATION FREQUENCY RESPONSE OF IRRADIATED BACTERIA TO A SECOND RADIATION EXPOSURE. Kada, T.; Doudney, C. O.; Haas, F. L. (Univ. of Texas, Houston). Mutat. Res., 3: 118-28(Apr. 1966).

Cultures of Escherichia coli strain WP_2 (tryptophan-requiring) were exposed either to uv or to x ray and then reincubated in minimal medium supplemented with a complex supply of amino acids. At intervals, samples were irradiated again, either with uv or with x ray. An increased mutation frequency response to the second exposure incubated cultures was observed upon plating on minimal agar medium. This increase was dependent on RNA and protein formation prior to the second irradiation. The increased response was lost with DNA synthesis. These results are discussed in relation to proposed repair mechanisms in radiation-exposed bacteria. (auth)

26679 ULTRAVIOLET MUTAGENESIS IN ESCHERICHIA COLI AT LOW TEMPERATURES. Ashwood-Smith, M. J.; Bridges, Bryn A. (Medical Research Council Radiobiological Research Unit, Harwell, Eng.). Mutat. Res., 3: 135-44(Apr. 1966).

The sensitivity of Escherichia coli B/r WP_2 (tryptophan-requiring) suspended in phosphate buffer to the lethal and mutagenic action of uv light is reported over the temperature range 22° to –196°. In the unfrozen state the sensitivity is unchanged from 22° to –10°. In the frozen state the sensitivity relative to the unfrozen state increases by a factor of seven as the temperature is lowered to –79°. At –196° the factor is reduced to four. The increase in sensitivity is dependent upon the frozen state being maintained during irradiation. Experiments with a sensitive strain E. coli WP2 hcr^- which has a reduced ability to excise thymine dimers reveal a complicated lethal response. At 22° the survival curve has a pronounced shoulder. At –79° this shoulder is abolished and the survival curve appears to run parallel to the ultimate slope of the curve at 22°. E. coli WP2 hcr^- is 2.5 times more sensitive to the mutagenic action of uv at –79° than at 22°. No temperature dependence between –5° and –79° comparable with that observed with bacteria was observed in the destruction of thymine by uv in a system in vitro. In both systems, however, the sensitivity at –196° was less that that at –79°. The enhancement of uv damage in the frozen state is also discussed in terms of its possible significance in the evolution of species. (auth)

26680 ANALYSIS OF INDUCED MUTATIONS IN ASPERGILLUS NIDULANS. I. UV- AND HNO_2-INDUCED MUTATIONS. Calvori, Clara; Morpurgo, Giorgio (Centro Internazionale di Chimica Microbiologica, Rome). Mutat. Res., 3: 145-51(Apr. 1966).

A method is described that permits the selective detection of forward and back mutations for a single cistron in Aspergillus nidulans. The method also permits an easy phenotypic distinction among true back mutants and suppressor mutations. The rate of spontaneous, uv- and HNO_2-induced retromutations was studied in 15 uv- and 14 HNO_2-induced mutants. Most of the uv-induced mutants can be interpreted as due to a base substitution while HNO_2-induced mutants must be due to a different mechanism. Two mutants of this group present a rate of spontaneous retromutation 20 to 40 times higher than the rate of forward mutation in the whole cistron. The spontaneous rate of retromutation was not modified by treatment with five reference mutagens. (auth)

26681 X-RAY-INDUCED MUTABILITY OF POLYGENES CONTROLLING HATCHING TIME IN DROSOPHILA MELANOGASTER. Pulitzer, John Finali (Univ., Pavia, Italy). Mutat. Res., 3: 158-66(Apr. 1966).

Hatching time is a suitable parameter for the study of polygenic x-ray induced mutations in Drosophila melanogaster in the heterozygous state. Because eggs are relatively closed systems until the moment they hatch, many environmental complications are avoided. Moreover, by means of paired observations it is possible to measure minute changes in hatching time and thus to discern mutations with very small metrical effects. Eggs of non-irradiated females inseminated by irradiated males were studied. Analysis of the results by Bateman's method indicated that the minimum incidence of mutations in sperm was about 26% at 1200 R and 49% at 2400 R. The mean metrical effect of each mutation was to retard hatching time by about 24 min. By this method it is not possible completely to exclude the possibility of some non-genetic physiological component of the changes observed. However it seems rather unlikely that such a component will be significant to any great extent. (auth)

26682 RADIATION-SENSITIVE MUTANTS OF PSEUDOMONAS AERUGINOSA WITH REDUCED HOST-CELL REACTIVATION OF BACTERIOPHAGES. Holloway, B. W. (Univ. of Melbourne, Parkville, Australia). Mutat. Res., 3: 167-71(Apr. 1966).

Procedures are described that were used in the isolation of uv-sensitive mutants of Pseudomonas aeruginosa with reduced sensitivity to bacteriophages. The mutants were characterized quantitatively by using each of them in turn as indicator strains to plate phage B_3 that had received varying doses of uv. The bacterial isolates showed a range of responses to bacteriophage infection. (C.H.)

26683 ABSENCE OF Y-SUPPRESSED LETHALS IN AN AUTOSOME OF DROSOPHILA. Ben-Zeev, N.; Falk, R. (Hebrew Univ., Jerusalem). Mutat. Res., 3: 174-6(Apr. 1966).

Male Drosophila melanogaster were exposed to 3 to 4 kR x radiation and mated three times, on days 1 to 3, 3 to 5, and 5 to 9 after irradiation. The frequency of chromosome lethals in offspring was determined for each group. Data are included on the constitution and phenotypes of the sex chromosomes of each test generation. Not a single y-suppressed lethal was found in the second chromosome although 15 to 18 were expected by the standard of the x-chromosome. Possible explanations are suggested. (C.H.)

26684 MODIFICATION OF THE LIFE EXPECTANCY BY A SINGLE X-RAY IRRADIATION. Angerstein, W. (Forschungsinstitut fuer Tuberkulose und Lungenkrankheiten, Berlin). Naturwissenschaften, 53: 108(1966). (In German).

In order to determine the dependence of the life expectancy of white mice on the intensity of the radiation dose from single irradiations 8 groups of female mice were x irradiated with single doses of 21, 41, 82, 152, 223, 316, 421, and 543 R. A group of 300 non-irradiated animals were used for the determination of the normal life expectancy. The mice were maintained under normal conditions up to their death. The life expectancy of each research group was determined as the arithmetic mean of the life expectancy of the individual animals. The results showed that at relatively small doses under 50 R the life expectancy was significantly reduced. The life expectancy of unirradiated animals was 700 days and this value decreased to 543 days after irradiation with 543 R. The results showed that the life expectancy–radiation dose dependence followed an exponential law. (J.S.R.)

26685 BETA-RAY EXTRACORPOREAL IRRADIATOR. Gilbert, C. W.; Lajtha, L. G. (Paterson Labs., Manchester, Eng.). Phys. Med. Biol., 11: 281-5(1966).

A description is given of a compact ^{90}Sr β-irradiator for the extracorporeal irradiation of blood. An arterial-venous shunt is used and no external pump is necessary. Doses between 3,000 and 18,000 rads per day can be given to the blood of a patient and the irradiation can be continuous for many days. (auth)

26686 EFFECT OF X IRRADIATION ON SOME NEUROENDOCRINE REACTIONS IN DOGS. Shkhinek, E. K. (Inst. of Experimental Medicine, Leningrad). Probl. Endokrinol. Gormonoterap., 12: No. 1, 84-9(1966). (In Russian).

Stimulation of subcortical formations of the brain through chronically implanted electrodes usually causes a rapid increase of the blood 17-oxycorticosteroid content, which normalizes in 3 to 4 hours. In some dogs the effect obtained with hypothalamus stimulation was the reverse. Total x irradiation in a dose of 600 R led to inversion of cortical substance reactions, noted at short periods after the action of ionizing radiation; later this inversion was seen to repeat periodically. The data obtained permit the assessment of the significance of brain subcortical areas in the involvement of the hypophysis-adrenal cortex system in the radiation reaction, as well as in functional disturbances of this system manifest in radiation sickness. (auth)

26687 EXPERIMENTAL CONTRIBUTIONS TO THE CLARIFICATION OF THE ALTERATIONS INDUCED BY IONIZING RADIATION IN THE SERUM PROTEIN PATTERN. Marcante, M. L.; Cappelli, L. (Istituto Regina Elena per lo Studio e la Cura dei Tumori, Rome). Radiobiol. Radioterap. Fis. Med., 21: 3-16(Jan.-Feb. 1966). (In Italian).

Results obtained on groups of selected rats showed that changes in the serum protein fractions, well demonstrable from both the physico-chemical and physical standpoints, occur following 300 rad x irradiation. The mechanism of these alterations was related to a change in the balance which rules the exchanges between blood and tissue, rather than to an irregular protein synthesis. (auth)

26688 INDUCTION OF STREPTOMYCIN-DEPENDENT MUTATION IN BACILLUS SUBTILIS WITH NITROUS ACID, DIETHYL SULFATE, AND ULTRAVIOLET LIGHT. Tong, Ke-zhong (Inst. of Genetics, Academia Sinica, Peking); Li, Ming-feng; Mo, Hsin-chaun; Siang, Wan-nien. Sci. Sinica (Peking), 15: 562-9(Apr. 1966).

In a population of streptomycin-sensitive Bacillus subtilis strain ATCC 6633, streptomycin-dependent mutants appeared immediately after HNO_2-treatment without cell division, DNA replication, and transition. Streptomycin-dependent mutation was also induced by diethyl sulfate or ultraviolet light. In both these cases, post-treatment conditions conducive to cell multiplication were found to be necessary to the establishment of mutation. It is suggested that uracil and/or hypoxanthine may play a coding role in the DNA genetic code. (auth)

26689 EFFECT OF UV RADIATION ON THE CHOLESTEROL AND GLUCOSE OF LIVER AND SKIN. Pora, E. A.; Ghircoiasiu, M.; Madar, I. Stud. Univ. Babes-Bolyai, Ser. Biol., No. 2, 117-20(1964). (In Rumanian).

The effect of uv radiation on the cholesterol and glucose contents of the liver and skin of rats irradiated for 6 days was observed. Uv irradiation stimulates cholesterol genesis and causes at the same time a new distribution of cholesterol in the different tissues. Hepatic cholesterol increases 33.8% and skin cholesterol 31.1%. The consumption of glucose increased 27.3% with respect to the nonirradiated rats as a result of the intensification of the metabolic processes. (tr-auth)

26690 EFFECTS OF COMBINED X-RAY AND RIBONUCLEIC TREATMENTS ON THE DNA METABOLISM IN RATS CARRYING LYMPHATIC SARCOMA. Manoilov, S. E.; Orlova, E. I. Uzb. Biol. Zh., No. 1, 3-6(1966). (In Russian).

The biosynthesis of DNA in the tissues of tumor carrying rats was investigated on the 17th day after initiation of various therapeutic conditions (ribonuclease, irradiation, and irradiation and ribonuclease). The development of the tumor intensified the biosynthesis of the DNA in the spleen and inhibited it in the small intestine. Local irradiation of the abdominal tumor lead to a reduction of the biosynthesis of the DNA not only in the tumor but also in non-irradiated tissues of the spleen and small intestine. The combined treatment of radiation and ribonuclease reduced the stimulating effect of ribonuclease on the biosynthesis of DNA in the tumor and also reduced the biosynthesis of DNA in the spleen. The concentration of DNA in the tissues was essentially not affected under the present experimental conditions. (tr-auth)

26691 IMMUNOLOGICAL PROBLEMS OF RADIATION CHIMERISM. Rengerova, Alena (Microbiological Inst., Prague). Vestn. Cesk. Akad. Ved, 74: 462-3(1965).

An organism exposed to a lethal irradiation dose cannot react immunologically to foreign antigens. When foreign blood-forming cells are implanted into individuals who are treated in this manner, a more or less permanent chimerism is produced. Therapy after administration of a lethal dose of irradiation, and the noxious effects of chimerism are discussed. Successful experimental prevention of the secondary disease caused by chimerism, on the basis of induction of immunological tolerance, is described. The immunological role of the thymus in mammals is discussed. Transplantation therapy after irradiation and irradiation to facilitate transplantation therapy are discussed. (CFSTI)

26692 PATHO-ANATOMICAL FINDINGS ON PIGS EXPOSED TO WHOLE-BODY IRRADIATION WITH GAMMA RAYS. Otupal, P.; Pawel, O.; Kalousova, V. (Veterinary Research Center, Prague). Vet. Med. (Prague), 10: 641-6 (Nov.1965).

A dose of 450 R γ radiation did not evoke radiation sickness in swine under the experimental conditions used. In the acute stages of the radiation sickness induced by exposure to 700 R, hemorrhagic diathesis was found in all organs and tissues. The skin of the caudal area of the ventral part of the body and the medial area of the pelvic extremities showed typical localization of hemorrhages. The hemorrhages were also observed in the mucous membrane of epiglottis, epicardia, and in the gastrointestinal and urogenital tracts. Diphtheroidally necrotic changes were found in 20% of the animals in the intestinal tract, and in 50% in the mucous membrane of the large intestine and the cecum. (CFSTI)

26693 HISTOPATHOLOGICAL CHANGES IN PIGS EXPOSED TO WHOLE-BODY IRRADIATION BY GAMMA RAYS. Otoupal, P. (Veterinary Research Center, Prague). Vet. Med. (Prague), 10: 647-56(Nov. 1965).

Swine were exposed to γ doses of 450 and 700 R. Greatest changes were found in lymphatic nodes and in the spleen. On the 11th day after exposure signs of nodular regeneration appeared and lymphoid tissue regeneration was observed between the 14th and 17th days. Pigs irradiated with a dose of 700 R showed signs of agglomeration of protoplasm in liver cells as well as vacuolization and degenerative changes in the form of pyknosis and karyolysis. Kidneys and the CNS suffered damage not visible macroscopically. (CFSTI)

26694 DYNAMICS OF THE CHANGES IN THE NUMBERS OF CELLS IN PERIPHERAL BLOOD IN PIGS AND GOATS SUBJECTED TO WHOLE-BODY IRRADIATION WITH ^{60}Co. Pospisil, J.; Beran, M. (Charles Univ., Prague. Veterinary Research Center, Prague). Vet. Med. (Prague), 10: 657-62(Nov. 1965).

Dynamics of post-irradiation changes in numbers of individual cells of peripheral blood were investigated in goats irradiated with 500 to 700 R, and in pigs irradiated with 450 to 700 R γ radiation. Typical postirradiation leucopenia and lymphopenia were found; their intensity and duration were a function of the amount of irradiation. A definite decrease in the number of reticulocytes was found in pigs. (CFSTI)

26695 CHANGES OF WHITE BLOOD CELL COUNT IN DOMESTIC FOWL (GALLUS DOMESTICUS) DUE TO THE INFLUENCE OF AN INCREASING DOSE OF X RAYS. Prochazka, Z. (Research Inst. for Veterinary Medicine, Brno). Vet. Med. (Prague), 10: 663-70(Nov. 1965).

Chickens in groups of 10 were x irradiated with increasing doses of ionizing radiation in the range 600 to 2000 R. The degree of a single leucopenic response depends on the dose of ionizing irradiation up to the limit of LD_{50}. Above a dose of 1400 R the rate varies between 5 and 10% and does not decrease further. Convalescence is also a function of the amount of irradiation. Up to the limit of 1400 R conva-

lescence takes place; between 1800 and 2000 R the death rate approaches 100%. (CFSTI)

26696 CHARACTERISTICS OF ENERGETIC AND NITROGENOUS METABOLISM IN BRAIN IN ACUTE RADIATION DISEASE. Veksler, Ya. I. (State Medical School, Rostov-on-Don, USSR). Vopr. Med. Khim., 12: 26-30(1966). (In Russian).

Decrease in the content of ammonia as well as of labile phosphate of ATP and ADP, in the brain was observed in x-irradiated rats in hypothermia. (auth)

26697 IONIZATION-RADIATION-INDUCED DEATH. Wang, Pao-han (Microbiology Inst., Peking). Wei Sheng Wu Hsueh Pao, 9: 201-2(1963).

The target theory of biological effects of ionization radiation is reviewed. Results are reported from studies on the effect of γ radiation on yeast Saccharomyces cerevisiae. It was found that the relation between the survival rate and the radiation dose was somewhat sigmoid. The median lethal dose (LD_{50}) and the mean lethal dose (LD_{63}) were 16.5 kR and 20.65 kR respectively, and the median lethal dose of γ radiation for the yeast (Candida utilis) was found to be 52.2 kR. Death rate probability is discussed. (ATD)

26698 EFFECTS OF X IRRADIATION ON REPRODUCTION IN YEAST. Hsueh, Yu-ku; Yin, Kuang-lin; Chang, Yung-ch'ing (Microbiology Inst., Peking). Wei Sheng Wu Hsueh Pao, 9: 356-61(1963).

The effect of x irradiation on the reproduction of a yeast strain Saccharomyces cerevisiae was studied. Its sensitivity to x irradiation at different growing stages was determined by its survival and sporing rates. The logarithmic phase in the growth of yeast, i.e., the 17 hour cultivation period was the most sensitive, the lag phase, i.e., the 5-hour cultivation period less sensitive, and the stationary phase, the 48-hour cultivation period, the least sensitive. The relationship between the number of surviving yeast cells and x irradiation dosage was represented by a somewhat sigmoid curve. The median lethal dose (LD_{50}) and the mean lethal dose (LD_{63}) were found to be 16.5 kR and 20.65 kR respectively. X irradiation delayed the initiation of yeast cell division. Within certain limits, (5 to 150 kR), radiation dosage did not influence the constant value in the growth curve equation of the logarithmic phase of yeast. The growth curve of yeast irradiated by different radiation doses was determined mainly by the number of surviving cells and the length of time of the lag phase. There was a linear relationship between the length of the lag phase and radiation dosage. (ATD)

26699 EFFECT OF ULTRAVIOLET RADIATION ON SCHIZOSACCHAROMYCES JAPONICUS. Ts'ai, Chin-k'o; Men, Ta-p'eng (Microbiology Inst., Peking). Wei Sheng Wu Hsueh Pao, 10: 488-93(1964).

The AS 2.1147 strain of Schizosaccharomyces japonicus, incubated at 30°C was subjected to ultraviolet radiation from a Phillips 15-watt UV lamp. The maximum effect was observed at a wavelength of 2534 Å. The survival curve of the Schizosaccharomyces resting cells in relation to the dose of ultraviolet radiation is logarithmic in form, but trails off when high doses are given. The frequency of biochemical mutations increases non-linearly with the dose of ultraviolet, giving an S-shaped curve which drops rapidly at high doses. The ultraviolet radiation not only both stimulates and depresses sexual reproduction (spore formation) in Schizosaccharomyces, but also induces polyploidy. These polyploid cells multiply normally, and it is suggested that diploid cells are a normal component of the life cycle of S. japonicus. Ultraviolet radiation also produces changes in the form of the Schizosaccharomyces cells, as well as changes in microbiological characteristics, most of which are stably inherited by sexual reproduction. In certain cases, a change in structure of the yeast colony may also be produced. (ATD)

26700 STUDY OF THE VIRULENCE OF THE BRUCELLA VACCINE STRAIN AFTER BEING IN IRRADIATED ANIMALS. Shevtsova, Z. V. (Inst. of Epidemiology and Microbiology, Academy of Medical Sciences, USSR). Zh. Mikrobiol. Epidemiol. Immunobiol., No. 3, 56-8(Mar. 1965).

Experiments were performed on guinea pigs inoculated with Brucella and irradiated with a dose of 200 R (20 to 30% of the animals died with 30 days). Twenty-five cultures were isolated from irradiated animals, four from the controls. All retained their original morphological, cultural, and antigenic properties. Twenty cultures checked after 3, 10, 20, and 30 days in the irradiated animals did not differ from the original strain with regard to their ability to spread in the organism. The other five cultures showed some increase in their infective ability. (CFSTI)

26701 THE EFFECT OF IRRADIATION ON THE MULTIPLICATION OF BACTERIA OF THE VACCINE TULAREMIA STRAIN IN THE ORGANISM OF MICE AND GUINEA PIGS. Shevelev, A. S. (Smolensk Medical Inst., USSR). Zh. Mikrobiol. Epidemiol. Immunobiol., No. 4, 107-11(Apr. 1966). (In Russian).

The effects of whole-body x irradiation on multiplication of tularemia bacteria were studied at the site of injection, and in lymph nodes blood, and various organs of vaccinated guinea pigs and mice. In guinea pigs irradiated two hrs prior to vaccination, bacterial multiplication was increased without increase in duration of infection. Irradiation intensified the tularemia syndrome in mice leading to death of the animals. (H.G.D.)

Radiation Effects Therapy and Countermeasures

26702 THE RADIOPROTECTIVE EFFECT OF GLYCINE ON SOME ENZYMATIC SYSTEMS DURING X-RAY IRRADIATION. Capilna, S. Acad. Repub. Pop. Rom., Stud. Cercet. Fiziol., 9: 369-74(1964).

Glycine exerts a protective effect on catalases when intraperitoneally administered in a dose of 266 μM to mice. The protection is more efficient if administration precedes irradiation. It seems likely that noxious decomposition products resulting after irradiation are more rapidly neutralized in cells at the very moment of their appearance, than after the effect has already occurred. Possibly, glycine directly and rapidly contributes to the recomposition of the porphyrine nucleus in the catalase structure. The radioprotective activity of glycine is not so evident in the case of other enzymatic systems. (Rum. Sci. Abstr.)

26703 DISTRIBUTION AND CHEMICAL FORMS OF DIETHYLDITHIOCARBAMATE AND TETRAETHYLTHIURAM DISULFIDE (DISULFIRAM) IN MICE IN RELATION TO RADIOPROTECTION. Stroemme, Johan H.; Eldjarn, Lorentz (Univ. of Oslo). Biochem. Pharmacol., 287-97(Mar. 1966).

The distribution and the chemical nature of the radioprotective thiol, diethyldithiocarbamate, and the corresponding disulfide, disulfiram, were studied in mice, using ^{35}S-labeled compounds. The results showed that the metabolism of these two compounds essentially follows the same pathways, since the disulfide immediately upon resorption becomes converted to the thiol. A similar relative distribution between organs was found with diethyldithiocarbamate and disulfiram. There was no particular accumulation in organs known to play an important role in the radiation syndrome. Ten to 20 times higher total concentrations of metabolites were obtained with diethyldithiocarbamate than with disulfiram, a finding which alone explains why, under the conditions used, only the former possesses radioprotective properties. Moreover, diethyldithiocarbamate gave rise to high concentrations of free, unmetabolized, thiol, whereas no free thiol was found after the injection of disulfiram. When labeled diethyldithiocarbamate as well as disulfiram had been injected, measurable amounts of ^{35}S was recovered bound to proteins. The protein-bound radioactivity derived from diethyldithiocarbamate, however, did not make up for more than 1–3 percent of the total present, and only a fraction of this appeared to be bound by mixed disulfide linkages. The results, which are discussed in relation to chemical protection, suggest the necessity of free diethyldithiocarbamate in the organism in order to obtain radioprotective effect. (auth)

26704 PROGENY OF RADIOPROTECTED RATS AFTER EXPOSURE TO LETHAL DOSES. Dimitrov, L. Compt. Rend. Acad. Bulg. Sci., 18: 1043-5(1965). (In Russian).

Groups of white rats were given an x ray dose of 800 R, which was 100% lethal to a control group of rates. Group I received a combination of radioprotective amines intraperitoneally 7 to 10 min before irradiation. Group II received the radioprotective amine treatment, and also an antibiotic such as streptomycin which was administered daily starting 2 to 3 days after the irradiation. Group III received the treatment of groups I and II, and also a bone marrow perfusion of 40 to 60 million viable cells 20 to 24 hours after the irradiation. Group IV received the treatment of the previous three groups, and a daily vitamin B_{12} dose of 30 gamma/kg weight from the 7th to 10th day after irradiation. The survivals were found to be 45.5% for group I, 69.5% for group II, 59% for group III, and 89% for group IV. In addition, it was found that group IV was more successful in having progeny which were apparently healthy. The combined treatment protected the irradiated rats from sterility to a certain extent. (TTT)

26705 EFFECT OF POTENTIAL RADIATION PROTECTIVE COMPOUNDS ON BLOOD CLOTTING. Sztanyik, Laszlo; Geszti, Olga; Hegyi, G.; Fogaras, K. (Hungarian People's Army Health Service, Budapest. National Frederic Joliot-Curie Research Inst of Radiobiology and Radiation Hygiene, Budapest). Honvedorvos, 17: 205-12(Aug.-Sept. 1965).

It was determined that SH-compounds, known for their radiation protective effect (e.g., MEA), and potential SH-compounds (e.g., AET and APT) inhibit the coagulation of recalcified rabbit plasma like cysteine; AET and APT can even prolong the time required for coagulation with thrombin. Such effects are exerted by all ring analogues of AET and APT which are converted, in vitro, into compounds with a free SH group. The inhibition of blood plasma clotting is probably related to the formation of a mixed disulfide linkage between the SH compound and some pro-coagulant. The inhibition of blood clotting is not necessarily related to the radiation protective effect. This led to the conclusion that the theory of mixed disulfide linkage of Eldjarn and Pihl does not provide a sufficient explanation for the mechanism of the radiation-protective effect. (CFSTI)

26706 SYNTHESIS OF POTENTIAL ANTIRADIATION AGENTS. PART II. SOME 1,3-THIAZANE DERIVATIVES. Mamdapur, V. R.; Choughuley, A. S. U.; Chadha, M. S. (Atomic Energy Establishment, Trombay, India). J. Indian Chem. Soc., 43: 37-40(Jan. 1966).

Several 1,3-thiazane derivatives were synthesized as potential antiradiation agents. Crotonic acid and itaconic acid as well as methyl methacrylate on treatment with ammonium dithiocarbamate provide the open-chain intermediates, which, on acid cyclization, result in the corresponding 2-thiono-4-oxo-1,3-thiazanes. Independent syntheses of these products were made and the spectrophotometric evidence in support of their structures is discussed. (auth)

26707 HALOGENATED THYMIDINE ANALOGUES AND CELLULAR RADIOSENSITIZATION. Kriss, Joseph P. (Stanford Univ. School of Medicine, Palo Alto, Calif.). pp 305-22 of CONF-651111.

The role of halogenated thymidine analogues in inducing cellular radiosensitization is briefly reviewed. Radiosensitization to ultraviolet light and to x rays may be observed in viral, bacterial, and mammalian cells in vitro and is proportional to the extent to which the analogue is incorporated into deoxyribonucleic acid (DNA) in place of thymidine. The results of some studies involving the techniques of blood and renal clearance, tissue distribution, and chemical analysis are summarized. In addition, the application of the technique of radiorespirometry is described, and results of such studies performed in man are presented. Some of the advantages and limitations of these various techniques are discussed. The metabolic studies indicate that the choice of compound, route of administration, quantity and timing of administration, and rate of catabolism are important factors bearing on the possible successful clinical use of these compounds as radiosensitizing agents. (P.C.H.)

Radiation Hazards and Protection

See also HEALTH AND SAFETY

26708 (AHSB(RP)R–69) MAXIMUM PERMISSIBLE CONCENTRATIONS IN AIR FOR COMPOUNDS OF ^{239}Pu. Dolphin, G. W.; Duncan, K. P.; Dunster, H. J.; Jackson, S. (Authority Health and Safety Branch, United Kingdom Atomic Energy Authority, Harwell (England)). Apr. 1966. 13p. Dep. mn. BIS $0.50. HMSO 2s. 6d.

The derivation of values for $(MPC)_a$ as given in ICRP Pub 2 (1959) for soluble and insoluble plutonium is briefly reviewed for the cases of bone, liver, and lungs as organs of reference. In the model used in ICRP Pub 2 (1959) for the calculation of the $(MPC)_a$ for insoluble radioactive dusts in the lung it was assumed that 12½% of the inhaled radioactivity is transferred to the body fluids. This transfer could lead to a build up of radioactivity in a body organ other than the lung. However recent data both from dog experiments and from human autopsies show that this is not the case and the lung is the critical organ following inhalation of plutonium oxide. Inhaled plutonium nitrate is fairly readily transferred to the liver and bone and consequently the more restrictive $(MPC)_a$, for soluble plutonium, must be used when this compound is involved. A list of plutonium compounds is given and divided into those compounds behaving like plutonium nitrate and those behaving like plutonium oxide in the human body. (auth)

26709 EXPERIMENTAL DETERMINATION OF THE AVERAGE LINEAR ENERGY TRANSFER (LET) OF COMPTON ELECTRONS IN TISSUE-EQUIVALENT MATERIALS AS A FUNCTION OF THE PRIMARY QUANTUM ENERGY. Abel, H.; Regel, K.; Rossbach, H.; Eichhorn, K.; Haberer, G. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernenergie, 9: 57-62(Feb. 1966). (In German).

The ICRP and ICRU propose to include information concerning the LET of charged particles in describing the irradiation condition in radiation experiments. A method and the experimental equipment for the determination of the average LET, average-weighted over the track-lengths distribution, are described. The measured values of average LET are given as a function of the quantum energy E_γ (0.08 Mev $\leq E_\gamma \leq$ 2.75 Mev). The average LET in tissue can be inferred from the first half-value layer of the radiation in tissue-equivalent material. (auth)

26710 ^{90}Sr IN DIET IN POLAND (1 AUGUST 1962 TO 31 JULY 1963). Czosnowska, Wanda (Central Lab. for Radiological Protection, Warsaw). Nukleonika, 11: 70-1 (1966).

Data are presented on the average daily intake of ^{90}Sr in Poland from August 1962 through July 1963. (M.C.G.)

26711 SPACE RADIATION AND ITS BIOLOGICAL IMPACT. Moll, Ignacio Marco. Rev. Aero. Astronautica, 25: 860-6(Oct. 1965). (In Spanish).

A general review of space radiations of both solar and cosmic origin, describing their biological effects and outlining methods of protecting astronauts from such radiations is given. Types of radiations and their characteristic techniques of radioactive dosimetry are briefly described. The short and long-term effects of the radiations on cell division, various organs, the nervous system, and blood are considered. Long-range results are thought to be mainly genetic, due to the effects of radiation on the DNA macromolecule. The chemical structure of DNA is described in some detail, and the mechanism by which radiation causes changes in it is discussed. It is considered that suitable shielding may adequately protect against cosmic rays. (Int. Aerospace Abstr.)

26712 EFFECTS OF IONIZING RADIATION IN ANIMALS PROTECTED WITH HYPOXIA OR WITH CHEMICALS. Mazzella, G.; Paolucci, G. Riv. Medi. Aeronaut. Spaziale, 28: 302-12(July-Sept. 1965). (In Italian).

Experimental investigation performed on 120 mice

Balb/c of both sexes divided into groups to test the possibility of protection from the lethal effects of ionizing radiation, after treatment respectively with ethyl-palmitate, i.v. and i.p., dosed 2.5/3.5/kg, 48 hr prior to irradiation, with zymosan i.p., dosed g 190/kg, given three times prior to and twice after irradiation, with a 6% oxygen mixture, during irradiation. The results showed, after 100 days, a survival rate of 25% in the group treated with ethyl-palmitate, and of 94% in the group irradiated during hypoxia. The group treated with zymosan died earlier than the control group. It is concluded that a prolonged but impermanent protection from ionizing injuries can be achieved with different processes such as with drugs given prior to irradiation. (auth)

26713 INTERNAL RADIATION ABSORBED DOSE. Smith, Edward M. (Cornell Univ. Medical Coll., New York). pp 649-67 of CONF-651111.

The problems inherent in absorbed-dose calculations for radiopharmaceuticals are pointed out, and the progress in these various problem areas is discussed. The basic equations for calculating the absorbed dose are presented, and the relative merits of the absorbed fraction method are compared to the method using the average geometrical factor and specific gamma-ray constant. Tabulated values for the total local energy deposition per disintegration, photon yields, and specific gamma-ray constant for several radionuclides of current interest in nuclear medicine are given. The relevance of nonhomogeneous distribution of a radionuclide in an organ and other biological considerations are discussed with respect to the significance of the absorbed-dose calculation. (auth)

26714 GUIDELINES FOR SAFE USE OF RADIOPHARMACEUTICALS. LeRoy, George V. (Univ. of Chicago, Argonne Cancer Research Hospital, Chicago). pp 669-78 of CONF-651111.

Available satisfactory guidelines and use of them in a fashion that is compatible with medical ethics and consistent with the practice of industrial users of by-product material is discussed. Special attention is given to the different classes of people on which radioisotope procedures are performed. Maximum permissible doses are stressed. (P.C.H.)

26715 U. S. ATOMIC ENERGY COMMISSION LICENSING AND REGULATION OF RADIOPHARMACEUTICALS. Cunningham, Richard E. (Atomic Energy Commission, Washington, D. C.). pp 679-88 of CONF-651111.

The development and present status of the AEC regulatory as it pertains to the use of radiopharmaceuticals is described. Regulatory goals for the future and some of the factors that might influence the achievement of this goal are also discussed. (P.C.H.)

26716 U. S. FOOD AND DRUG ADMINISTRATION POLICY ON RADIOPHARMACEUTICALS. Hauser, Julius (Dept. of Health, Education and Welfare, Washington, D. C.). pp 689-95 of CONF-651111.

The U. S. Food and Drug Administration policy on radiopharmaceuticals with regard to adulterated and misbranded drugs, new drugs, investigation of new drugs, requirements for tests in humans, new-drug application, and temporary exemption of investigational radiopharmaceuticals are described. The effects of revised AEC regulations on new-drug applications are also discussed. (P.C.H.)

26717 GOVERNMENTAL RESPONSIBILITIES IN RADIOACTIVE DRUGS. Bruner, H. D. (Atomic Energy Commission, Washington, D. C.). pp 697-700 of CONF-651111.

The government is primarily charged with achieving a balance between the conservatism expected of the physician, who is charged with the patient's care, and the requirements of the research investigator eager to acquire new information about man. The licensing and regulatory activities of government take on the function of a stabilizing balance wheel since a regulatory agency must sense and coordinate both the wishes of the public and the needs of the groups for which it is responsible. (P.C.H.)

Radiotherapy and Radiodiagnosis

Refer also to abstract 27018.

26718 (NP-tr-1382) USE OF RADIOACTIVE KRYPTON ^{85}Kr IN THE STUDY OF VENTILATION UNIFORMITY AND DISTRIBUTION OF PERFUSION IN SEPARATE LUNGS I. PRESENTATION OF THE METHOD. Cellerino, A.; Catolla Cavalcanti, R. Translated by A. Crozy (U.K.A.E.A. Atomic Energy Research Establishment, Harwell, Eng.), from Minerva Nucl., 9: 160-71(1965). 39p. Dep. mn. JCL $3.60 fs, $1.37 mf.

A counting system is described that was developed to measure lung ventilation when ^{85}Kr was used as a tracer. The system provides data that may be used to evaluate the capillary perfusion in each lung separately, the effects of mechanical or functional disturbances of ventilation at the alveolar level, the lung clearance index in relation to time or the volume of air ventilated and percentage blood irrigation for each lung compartment, and may be combined with heart catherization or the administration of a tracer dye for the assessment of possible circulatory shunts. (22 references.) (C.H.)

26719 ELECTRON MICROSCOPIC AUTORADIOGRAPHY OF ALPHA PARTICLES AND PROTONS. Lindenbaum, A.; Alper, R. E. (Argonne National Lab., Ill.). Atompraxis, 12: 127-9(Mar. 1966).

Differences in the fine structure of tracks produced by alpha and proton irradiation in a thin photographic emulsion were studied with the electron microscope. (auth)

26720 FUTURE AVAILABILITY OF X-RAY FILM. Wilson, Robert A. (Univ. of Texas, Dallas). J. Amer. Med. Ass., 194: 514-15(Nov. 1, 1965).

Possible future shortages of silver halide x-ray film and available substitutes are considered, and the problem of increased patient radiation exposure with the use of substitute materials is mentioned. Since there is geologic evidence that in future decades production may continue to decline, the great dependence of roentgenographic diagnosis on silver is undesirable. Possible replacements for silver, including light-sensitive polymers are discussed. Fluoroscopy and xeroradiography are suggested as alternate techniques. The most important disadvantage of all substitutes for silver halide is the pronounced decrease in sensitivity toward x radiation, resulting in increased radiation exposures. Attempts to reduce the amount of silver in film emulsions have been partially successful but have at times resulted in films of unsatisfactory quality. Rationing of x-ray film is suggested as a means of control of its use. (TCO)

26721 COMBINED USE OF ^{125}I AND ^{131}I IN AUTORADIOGRAPHIC STUDIES OF NODULAR GOITER. Miller, J. Martin; Kawas, Bernice (Henry Ford Hospital, Detroit). J. Nucl. Med., 7: 188-96(Mar. 1966).

The sevenfold difference in the half lives of ^{125}I and ^{131}I permits the interpretation of autoradiographs prepared from tissue in which both are present. With proper selection of dosage, autoradiographs exposed from time zero can be made to reflect predominantly the distribution of ^{131}I; those from time 32 days or longer, mainly the distribution of ^{125}I. This technique has proved practical for the study of nodular goiters containing autonomous functioning tissue when one isotope is administered during suppression by endogenous or exogenous thyroxine, and the other during stimulation by exogenous TSH. The decay of one microcurie of ^{125}I is equivalent to 3 to 4 μC of ^{131}I in blackening dental film, and is equivalent to at least ten μC in blackening AR 10 stripping film. With a given tissue mixture of these isotopes, the relative effect of ^{131}I will be greater when using stripping film. (auth)

26722 SELENITE (^{75}Se) AS A TUMOR-LOCALIZING AGENT IN MAN. Cavalieri, Ralph R.; Scott, Kenneth G.; Sairenji, Eiko (Veterans Administration Hospital, San Francisco. Univ. of California, San Francisco). J. Nucl. Med., 7: 197-208(Mar. 1966).

To a degree which permits visualization of the tumor by scintillation scanning, ^{75}Se labeled selenite (SeO_3^{2-}) was shown to localize in intracranial, intrathoracic, and intra-abdominal neoplasms of humans. Assays of specimens of tumors obtained at operation or autopsy yielded concentrations of ^{75}Se ranging from 0.8 to 4.6 times the level in plasma. The results of distribution studies showed relatively high concentrations of label in liver and kidney and low levels in skeletal muscle. The calculated total-body radiation exposure based on a diagnostic dose of 4.0 μC per kg body weight and an average effective $T_{1/2}$ of 43 days (for 75% of the administered dose) is 1.14 rads. Preliminary clinical experience indicates that ^{75}Se selenite may offer specific tumor-localizing properties not found in other currently used agents. (auth)

26723 ^{197}Hg AND ^{203}Hg CHLORMERODRIN FOR EVALUATION OF BRAIN LESIONS USING A RECTILINEAR SCANNER AND SCINTILLATION CAMERA. Loken, Merle K.; Wigdahl, Luther O.; Gilson, J. Michael; Staab, Edward V. (Univ. of Minnesota, Minneapolis. Veterans Administration Hospitals, Minneapolis). J. Nucl. Med., 7: 209-18(Mar. 1966).

The results are presented of 432 patients conventionally scanned for the evaluationof brain lesions with ^{197}Hg-chlormerodrin studied in a retrospective blind study. Forty-two patients in which ^{203}Hg-chlormerodrin and ^{197}Hg-chlormerodrin was used as the radioactive agent were studied, and no significant difference in percentage of positive examinations was found; 107 patients, after receiving ^{197}Hg-chlormerodrin, were studied using both the scintillation camera and rectilinear scanning techniques. A comparison of the two methods used consecutively revealed that each gave information verifying the other and of essentially equal accuracy. (auth)

26724 DETECTION OF BONE LESIONS WITH THE ^{85}Sr SCINTISCAN. DeNardo, Gerald L.; Volpe, Joseph A. (Veterans Administration Hospital, Palo Alto, Calif.). J. Nucl. Med., 7: 219-36(Mar. 1966).

One hundred and sixty-four ^{85}Sr bone scintiscans were performed in 50 patients on 59 occasions. Correct interpretation of the bone scan required knowledge of the normal sites of increased radioactivity at the ends of the long bones, around the acetabula and sacroiliac joints, over the vertebrae, and carpal and tarsal bones. Thirty-two of fifty patients had an abnormal scan including 17 with metastases, nine with osteomyelitis, two with primary bone neoplasmas, two with lymphoma, one with Gaucher's disease, and one with Paget's disease. Fourteen of these patients had negative roentgenograms at the time of the scan. The bone scan was particularly useful in the early diagnosis of osteomyelitis and metastases, and in differentiating bone islands from osteoblastic metastases. (auth)

26725 RADIATION INJURIES OF RECTUM IN PATIENTS WITH CARCINOMA OF THE UTERINE CERVIX TREATED BY THE MODIFIED PARISIAN METHOD. Medvey, Wojciech; Szymczyk, Wislawa. Nowotwory, 16: 77-82(Jan.-Mar. 1966). (In Polish).

An analysis was made of injuries of the rectum in 79 patients caused by the therapeutic use of Ra applicators for carcinoma of the cervix. It was concluded that most radiation injuries appear within 2 yr of treatment and are more frequent in patients treated during stages I and II of carcinoma growth. Gamma radiation doses in excess of 5100 R increased the risk of injury of the rectum. (C.H.)

26726 EXPERIMENTAL STUDY OF THE PHOTON ENERGY SPECTRUM OF PRIMARY DIAGNOSTIC X-RAYS. Epp, Edward R.; Weiss, Herbert (Sloan-Kettering Inst. for Cancer Research, New York). Phys. Med. Biol., 11: 225-38(1966).

The photon energy spectra of primary diagnostic x-ray beams were studied experimentally over the kilovoltage region 45 to 105 kvp using scintillation spectroscopy techniques. A method was devised which allowed the photon beam to be collimated without perturbing it and which permitted close reproduction of measurements. Correction for spectrometer distortion of spectra was done by means of a digital computer. Results are presented in terms of photon fluence per energy interval versus photon energy. Mean energies and half-value-layers were computed from the spectra. The half-layers were compared with independent experimental determinations using ionization chambers with essentially energy-independent responses over the photon-energy region of interest. (auth)

26727 PERFORATIONS AND FISTULAE IN THE COURSE OF RADIOTHERAPY OF MALIGNANT TUMORS OF THE ESOPHAGUS. Babini, L.; Sassi, P. (Univ., Bologna). Radiobiol. Radioterap. Fis. Med., 21: 55-69 (Jan.-Feb. 1966). (In Italian).

The appearance of perforations and fistulae in esophageal neoplasms treated by radiotherapy was studied. It was concluded that the appearance of fistulae is dependent upon the degree of extra-esophageal extension of the neoplasm at the moment the treatment was carried out. (auth)

26728 FLUOROURACIL ALONE AND ASSOCIATED WITH IRRADIATION IN ONCOLOGY. Conte, Gianni; Fiorentino, Mario (Ospedale Civile, Padua). Tumori, 49: 379-88(Nov.-Dec. 1963). (In Italian).

Clinical studies were conducted in 54 patients with cancer to determine whether this drug would enhance the effects of radiotherapy. Forty-two cases were treated with 5-fluorouracil (5-FU) alone, and in 12 cases associated with irradiation. In the first course of treatment, 40 to 90 mg/kg in 4 to 6 days was given; some cases received a total of 10 to 30 mg in 1 to 2 years. Out of the 54 cases, 26 (48%) showed objective regression of the tumors; in addition, in 45 cases there was subjective improvement. Severe toxicity was often observed; slow intravenous administration of 5 decreasing doses, in 5 days, gave the best tolerance and the best results. Generally, the improvement obtained with 5-FU alone lasted 4 to 6 weeks, but was maintained for longer periods by weekly doses of 10 mg/kg. Its association with irradiation gave long improvement with small doses of x rays, even below 2000 R. The most favorable results were among breast and rectum carcinomas for the group treated with 5-FU alone, and among carcinomas of the lungs for the group treated also with irradiation. The toxicity of 5-FU combined with x rays depended on the extent of the irradiated field. (BBB)

26729 USE OF STABLE ISOTOPES AND ACTIVATION ANALYSIS FOR IN VIVO DIAGNOSTIC STUDIES. Wahl, Werner H.; Nass, Harold W.; Kramer, Henry H. (Union Carbide Corp., Tuxedo, N. Y.). pp 191-204 of CONF-651111.

Studies that involve the administration of stable tracer (orally or by injection) and its analysis in recovered samples of plasma or urine by thermal neutron activation analysis are described. The use of photoactivation for the determination of deuterium in biological systems is also reviewed. The details of two specific methods of applying the activation-analysis technique are given; determination of iron plasma clearance; and estimation of exchangeable calcium pool in children. (P.C.H.)

26730 PROPERTIES AND USES OF RADIATING MICROSPHERES. Grotenhuis, Ivan M. (Minnesota Mining and Mfg. Co., St. Paul). pp 205-16 of CONF-651111.

The properties and uses of a type of particulate material that offers greater flexibility in use are described. The material consists of tiny microspheres that can absorb and retain nearly any radioisotope. The microspheres can be produced in two forms; one is a ceramic matrix, and the other is plastic, which is of controlled particle size. Various leaching or soak tests to evaluate radioisotope retention when the medium is subjected to body fluids are also described. (P.C.H.)

26731 RADIOISOTOPES OF IODINE. Myers, William G. (Ohio State Univ., Columbus). pp 217-43 of CONF-651111.

Criteria are assigned to a model ideal radioisotope having a maximum gamma-ray merit ratio (i.e., ratio of usable signals to energy absorbed locally) for in situ and in vivo diagnostic applications. For in situ uses the gamma ray must provide adequate tissue penetration and be determinable efficiently by highly directional detectors as well. Properties of 11 of the 24 radioisotopes of iodine were

compared with the model with respect to half life, modes of decay, and gamma emissions which make them attractive or which limit their usefulness in nuclear medicine. (auth)

26732 PHARMACODYNAMICS OF SOME ^{99m}Tc PREPARATIONS. Harper, Paul V.; Lathrop, Katherine A.; Gottschalk, Alexander (Univ. of Chicago. Argonne Cancer Research Hospital, Chicago). pp 335-58 of CONF-651111.

Because of the favorable physical characteristics for scanning applications and the ready availability of ^{99m}Tc, studies of various ^{99m}Tc preparations were undertaken. The most readily available form of ^{99m}Tc, pertechnetate, serves excellently as an extracellular space tag in brain scanning, and because of its ionic properties, it localizes in the thyroid, salivary glands, and stomach in a manner very similar to iodide. It is usable as an agent for cisternography, especially when the rapid absorption from the subarachnoid space is blocked with perchlorate. Pertechnetate is distributed in the body in a manner rather similar to iodide, and excretion in human subjects is initially in the urine, about 35% in the first 48 hr, and subsequently in the stool, about 35% between 24 to 72 hr. Technetium-99m activity, carried on precipitated sulfur in colloidal form, is useful for reticuloendothelial-system tagging, and the localized material is not translocated to any significant extent. Liver, spleen, and bone-marrow scans are done routinely with this agent. A combination of reduced technetium and iron localizes (about 10 to 15% of the injected dose) in the kidney cortex and is a useful agent for kidney scanning. The remainder is largely excreted in the urine. Tagged albumin for blood-pool tagging, which is sufficiently stable to withstand aggregation, was prepared with a specific activity of 10 mc/mg, and pertechnetate-99m deposited on a platinum filament may be vaporized for inhalation scanning. Technetium thiocyanate was used as a liver-scanning agent where its localization is a polygonal-cell function rather than a Kupffer-cell function as with the sulfur colloid. (auth)

26733 RADIOACTIVE ORGANIC COMPOUNDS OF MERCURY. Wagner, Henry N. Jr. (Johns Hopkins Medical Institutions, Baltimore). pp 399-408 of CONF-651111.

The use of radioactive organic compounds of mercury in four principal areas of nuclear medicine is reviewed. Whether or not the higher gamma-photon energy of ^{203}Hg is a sufficient advantage over ^{197}Hg to outweigh the increased radiation dose to the kidneys when chlormerodrin is administered for brain scanning remains debatable. It is clear that ^{197}Hg in the chemical form of chlormerodrin and mercurihydroxpropane is the nuclide of choice for renal and splenic scanning, respectively. (P.C.H.)

26734 AGGREGATED ALBUMIN LABELED WITH VARIOUS RADIOISOTOPES. Taplin, G. V.; Johnson, D. E.; Kennady, J. C.; Dore, E. K.; Poe, N. D.; Swanson, L. A.; Greenberg, A. (Univ. of California, Los Angeles. Los Angeles County Hospital, Torrance, Calif. Los Angeles County Olive View Hospital, Calif. Memorial Hospital of Long Beach, Calif.). pp 525-52 of CONF-651111.

The development, preparation, particle-size measurement, toxicity, and antigenicity of radioalbumin macroaggregates were reviewed in relation to their applications for estimating regional blood flow to the lungs and other organs on the principle of temporary arteriolar blockade. Emphasis is placed on the importance of particle size regarding pulmonary toxicity, lung removal rates, and radiation exposure. The potential hazard of cerebral embolic complications from lung scanning was evaluated from long-term brain studies in monkeys. The need and advantages of producing macroaggregate suspensions of higher specific activity, of more uniform size, and with rigid size control are stressed. However, clinical experience in more than 1000 patients indicates that currently available macroaggregates of human serum albumin – ^{131}I are nontoxic and nonantigenic in man and are entirely safe for lung scanning in nearly all patients. (auth)

26735 RADIOACTIVE GASES. Matthews, C. M. E.; Dollery, C. T.; Clark, J. C.; West, J. B. (Hammersmith Hospital, London). pp 567-92 of CONF-651111.

Several radioactive gases are produced by the Medical Research Council cyclotron at Hammersmith Hospital: $^{15}O_2$, $C^{15}O_2$, $C^{15}O$, $^{11}CO_2$, ^{11}CO, and $^{13}N_2$. Oxygen-15, ^{11}C, and ^{13}N are all pure positron emitters with very short half-lives, and have been used for studies of lung function and of body CO_2 stores. Reactor-produced ^{133}Xe was also used. For lung-function studies, the radioactivity in a region of lung was measured with external scintillation counters. The measured counting rate depends on radioactivity in both alveolar air and blood. For many gases the slope of this counting-rate curve is a complex function of alveolar clearance and blood clearance of the radioactive gas. Alveolar clearance is limited by blood flow and solubility for most of the gases, but for labeled carbon monoxide it is probably limited by diffusion. The uptake of $C^{15}O_2$ into the blood is very rapid because it exchanges with the water space, through the equilibrium with carbonic acid. It can be used to measure regional blood flow and to detect cardiac shunts. $^{11}Co_2$ exchanges rapidly with an extracellular CO_2 pool. $^{13}N_2$ is much less soluble than ^{133}Xe, and so it is more suitable for measurement of ventilation and lung volume. (auth)

26736 RADIOISOTOPES OF GALLIUM. Hayes, R. L. (Oak Ridge Inst. of Nuclear Studies, Tenn.). pp 603-18 of CONF-651111.

Of the gallium radionuclides of possible interest in medicine, ^{68}Ga appears to offer the best qualifications for diagnostic use. Gallium-68 appears to be useful in the following ways: in the citrate form, with proper attention to carrier effects, as a rapid localizing agent for bone scanning; incorporated in a hydrous ferric oxide colloid as a potential scanning agent for bone marrow, liver, and spleen; and in an EDTA chelate form as an agent for brain scanning and possibly also as an agent for in vivo dynamic physiologic studies. (auth)

26737 PHARMACOLOGY OF RADIOACTIVE CESIUM SALTS. Carr, Edward A. Jr. (Univ. of Michigan, Ann Arbor). pp 619-34 of CONF-651111.

Two general developments that have permitted the conversion of cesium from a hazard to an aid are discussed. The first has been the choice of a proper isotope of Cs and the preparation of its salts in a form useful for clinical administration. The second general development stemmed from studies of the distribution of cesium in tissues at early periods after its administration, as opposed to its distribution at later times. The distribution and attempts to modify it are also discussed. (P.C.H.)

26738 METHOD AND APPARATUS FOR THE EXAMINATION OF MATERIALS USING X RAYS. Beronius, H. H.; Forberg, Sevald; Henrikson, Carl-Oskar; Soeremark, Sven A. R. (to Roentgenaktiebolaget Iso-X, Stockholm). Canadian Patent 723,258. Dec. 7, 1965. Priority date Nov. 8, 1961, Sweden.

^{125}I is the source of monoenergetic x rays of about 27 kev. The source area is only a few mm^2 and the relatively low energy makes it very suitable for dental work. When provided with the necessary radiation shield, collimation, and shutter, the entire assembly is small enough for insertion into a body cavity. Electrodeposition of radioiodine from an organic solvent such as acetone is the method of manufacture. (F.S.A.)

CHEMISTRY

Analytical Procedures

See also Separation Processes and Procedures

Refer also to abstracts 26640, 27019, and 27031.

26739 (AERE-R-5190) THE DETERMINATION OF OXYGEN IN URANIUM NITRIDE BY INERT GAS FUSION. Taylor, B. L.; Prior, H. A.; Perrett, B. S.; Bird, P. (Atomic Energy Research Establishment, Harwell (England)). Apr. 1966. 15p. Dep. mn. BIS $0.50 HMSO 2s. 6d.

An inert gas fusion apparatus for the determination of oxygen in uranium nitride is described. The sample is reacted with carbon in a high-temperature graphite resistance furnace and the carbon monoxide removed in a stream of high-purity helium. After oxidation of the carbon monoxide to carbon dioxide, the latter is frozen out in a multi-loop trap and finally measured in an open-well capillary manometer. A gas injection valve is used for test purposes. As an initial check on the method it was applied with success to oxygen determinations in various standard materials other than nitrides. When applied to uranium nitride the method gave results that appear to be completely satisfactory. (auth)

26740 (AERE-R-5192) THE DETERMINATION OF CARBON IN STAINLESS STEEL FROM COMPATIBILITY EXPERIMENTS WITH URANIUM CARBIDE AND PLUTONIUM CARBIDE–URANIUM CARBIDE. Crossley, D.; Milner, G. W. C. (Atomic Energy Research Establishment, Harwell (England)). Mar. 1966. 14p. Dep. mn. BIS $0.50. HMSO 2s. 6d.

A method is described for the determination of carbon content from 0.05 to 0.3% in stainless steels using sample weights of 25 to 30 mg. Samples are ignited in a stream of purified oxygen at 1350°C without a flux, and the carbon dioxide produced is measured manometrically. Recovery experiments carried out on an analyzed stainless steel, for the determination of carbon at the 0.06% level, showed the precision of the method to be 1.5% (coefficient of variation). The method was applied successfully to the determination of the carbon contents of small steel samples in experiments to study the compatibility of stainless steel with uranium carbide and plutonium carbide-uranium carbide mixtures. Some details are given of the compatibility experiments, of the sampling methods employed, and of the results obtained. (auth)

26741 (ANL–7100, pp 443-53) AN INERT GAS PURITY TESTER. McKee, J. (United Nuclear Corp., White Plains, N. Y. Development Div.).

The instrument consists of two components, a filament changer and a control unit. The filament changer, which is used inside the glovebox, supports a titanium filament and supplies electrical heating current to it. The hot wire filament is consumed by oxidizing impurities in the gas and its life is a measure of the total concentration of such impurities. (W.L.G.)

26742 (BNWL-SA–58) DETECTION OF PLUTONIUM IN BIOASSAY PROGRAMS USING NONELECTRICAL FISSION FRAGMENT TRACK DETECTORS. Brackenbush, Larry W.; Baumgartner, William V. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 7, 1965. Contract AT(45-1)-1830. 11p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

A bioassay program for plutonium or other fissionable materials using nonelectrical solid state fission fragment track detectors is described. The method is very sensitive, rapid, and reasonably accurate. Lexan plastic disks placed upon electrodeposited bioassay disks, exposed to an integrated thermal neutron flux of 10^{15} neutrons/cm^2, and etched in a caustic solution are used to detect less than 0.01 dis/min of plutonium alpha activity. This is five times lower than the present Hanford detection limit of 0.05 dis/min using NTA emulsion; the method can be extended to even smaller quantities by using a higher neutron flux or larger track counting areas. Studies of sample preparation techniques point out the need for total contamination control if such low detection levels are to be meaningful. Significant cross contamination and residual activity are detected when using equipment that was used previously in the deposition of about 1 dis/min of plutonium alpha activity. A TV monitoring system coupled to an optical microscope provides a display of the etch pits from the fission fragment tracks. This system greatly reduces the eyestrain and the time required for track counting. The definition of the etch pits is good and track counting is quickly and accurately performed. The use of these nonelectric fission fragment detectors with other fissionable materials offers unique and practical solutions to many health physics problems. (auth)

26743 (HMI-B–48) UEBER DIE ABSCHEIDUNG VON RADIOJOD IM ATEMFILTER DES AUER-REAKTOR-FLUCHTGERAETS. (On the Deposition of Radioiodine in Filters of a Small Reactor Circuit Device). Hacke, J.; Jacobi, W.; Tramme, K. (Hahn-Meitner-Institut fuer Kernforschung, Berlin (West Germany)). Feb. 1966. 28p. Dep. mn.

The deposition of radioiodine in the filter and both its constituents (fibrous filter and charcoal filter) was studied by the multiple-filter-method. By this method the different filterable iodine components in the air could be separated and their fractions determined. Elemental iodine and iodine attached to aerosols are effectively retained in the filter system. For a third, weak component, which probably is mainly methyl iodide, the filter is rather penetrable. The fraction of this component in the air decreased in inverse proportion to the iodine concentration in the air and was about 0.03% for a specific ^{132}I activity of 10^{-4} C/m^3. The corresponding total I penetrability through the filter is about 0.02%. The suitability of the device for the intended field of application is discussed. (auth)

26744 (HW-SA–3099) AUTOMATING REACTOR COOLANT QUALITY ANALYSES. Demmitt, T. F. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Apr. 10, 1964. Contract AT(45-1)-1350. 6p. (CONF-179–21). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From American Chemical Society Radionuclidic Exchange on Soils, Minerals, and Resins, Philadelphia, Apr. 1964.

Procedures for the determination of chloride, oxygen, hydrogen, and hardness in aqueous coolant streams are described. These analyses were selected because they serve to illustrate several of the types of instrumentation available for use in automated systems. The Hanford 100-N pressurized water reactor sampling and analysis system is also reviewed. Variables that will be monitored in the various coolant streams at N Reactor, and the reasons for selecting these variables are summarized. (P.C.H.)

26745 (IFA-IS–34) NEUE ASPEKTE UND MOEGLICHKEITEN FUER DIE ANALYSE STABILER IZOTOPE. (New Aspects and Possibilities for Analysis of Stable Isotopes). Mercea, V. (Institutul de Fizica Atomica, Academia R. P. R., Bucharest (Romania)). Jan. 1966. 35p. Dep. mn.

Increased emphasis on research in the field of isotopic effects and their application to other areas contributed to the further development of conventional analytical methods used for the study of stable isotopic mixtures. The sensitivity of methods, such as spectral analysis, interferometry, gas chromatography, nuclear spin resonance, and mass spectrometry has been increased during the past years. Isotopic gas chromatography was originally used as a purification method; subsequent developments made it possible to separate the components of mixtures, such as H_2–HD–D_2, without thereby affecting the distribution of the species. Separation is not limited to light molecules; it was even

found possible to separate completely deuterated glucose and manose from the nondeuterated, otherwise identical compounds. More recently, mass spectrographs have been employed as detectors in gas chromatographic studies, combining the high resolution of the column with the high specificity of the mass spectra. The optical methods include Fabry-Perot interferometry, used for atomic and molecular spectra and infrared studies. Recent refinement of mass spectrometry made it possible to determine the presence of individual ions. Application of a special type of mass spectrometer, the synchrometer, is also discussed. (51 references). (TTT)

26746 (ISO-SA-13) SPECTROGRAPHIC ANALYSIS OF THORIUM AND URANIUM FOR THE RARE EARTH ELEMENTS. Wing, N. S. (Isochem Inc., Richland, Wash.). Apr. 21, 1966. Contract AT(45-1)-1851. 10p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

A spectrographic method that permits the determination of rare earth impurities at the 1 ppM level is described. Tributyl phosphate was selected to separate the rare earths from the matrix material extractions made from 6 M HNO_3 solutions gave very good separation of the rare earths. Results obtained on analysis of 8 thorium and 10 uranium samples agreed very well with the known value. (P.C.H.)

26747 (LA-DC-7143) ON MOLECULAR WEIGHT DETERMINATION BY NUCLEAR MAGNETIC RESONANCE. Roberts, Edwin M. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [1963]. Contract W-7405-eng-36. 6p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

A technique for the determination of molecular weight, using NMR, was recently given by Barcza. Modifications to Barcza's method are described which increase the accuracy and usefulness of the method. (M.O.W.)

26748 (NBL-233) BIAS DETERMINATION OF MASS SPECTROMETRIC ISOTOPIC ANALYSIS OF BORON USING PREPARED STANDARDS AND SODIUM AND CESIUM TETRABORATE CHARGE MATERIAL. King, W. F.; Pucilowski, J. J. Jr. (New Brunswick Lab. (AEC), N. J.). May 1966. 8p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Certain differences between New Brunswick Laboratory and other laboratories in isotopic boron analyses were studied. Possible sources of errors in the NBL values were investigated by analyzing the same sodium tetraborate on two mass spectrometers (12-inch, 90° and 6-inch, 60°) for variations between instruments and by analyzing cesium tetraborate made from the same boric acid on the 12-inch, 90° instrument for effects due to different charge materials. Also, synthetic New Brunswick Laboratory standards were analyzed on both instruments for overall accuracy. No significant differences were observed between instruments or charge materials. The greatest deviation from the calculated values of the ratio was 0.10% with a relative 95% C. L. of 0.10% at the 50% boron-10 level and 0.072% with a relative 95% C.L. of 0.093% at the normal level. (auth)

26749 (PG-Report-695) ANALYTICAL METHOD FOR THE DETERMINATION OF METHYLBENZENES IN HUMIDRIER LIQUORS (GAS CHROMATOGRAPHY). (Production Group, United Kingdom Atomic Energy Authority, Sellafield (England)). 1966. 10p. Dep. mn. BIS $0.20. HMSO 1s. 2d.

A gas chromatography method for the determination of methylbenzenes in Advanced Gas Cooled Reactor Humidrier Liquors is described. The sample is mixed with an aliquot of a marker solution. Part of the mixture is injected into an Apiezon L chromatographic column at 100°C. After the required components have been eluted from the column the component peak heights relative to the marker peak height are used to determine the concentration of the methylbenzenes. Based on 11 results at the 1% level the precision was calculated as ±10%. The bias was estimated to be not greater than 2% at the 1% concentration level, and the limit of detection is approximately 5 ppM. (P.C.H.)

26750 (PG-Report-700) A SORPTION ANALYSER FOR THE DETERMINATION OF TRACE COMPONENTS IN GAS STREAMS. Davies, P. J.; Hamlin, A. G. (Production Group, United Kingdom Atomic Energy Authority, Capenhurst (England)). 1966. 20p. Dep. BIS $0.50. HMSO 2s. 6d.

A sorption analyzer derived from a gas chromatograph, and using the same gas stream as sample and carrier gas was developed. The trace component is allowed to adsorb on to the column over a period of time and then desorbed as a sharp peak by heating the column rapidly. The sensitivity is governed only by the mass flow of gas during the adsorption period. The analyzer was developed specifically to determine traces of ammonia in hydrogen in a closed system and is capable of monitoring 0–250 vpM or more in a 15-minute cycle. It can, however, be applied to any system where a suitable adsorbate/adsorbent combination exists, and is particularly applicable to equilibrium systems or to those containing dangerous or valuable constituents since there need be no overall change or loss. It can determine several materials simultaneously if their adsorptive properties differ sufficiently. (auth)

26751 (RAC-1478) DETERMINATION OF GAS IMPURITIES IN ALKALI METALS. Persiani, C.; Kelly, R. S. (Republic Aviation Corp., Farmingdale, N. Y.). July 1, 1963. 11p. (RD-TR-63-607).

The more promising methods for the determination of gaseous impurities in alkali metals are reviewed and evaluated. Gas fusion, spectral, isotope dilution, and radioactivation methods were selected as the most promising. A table on some of the physical properties of alkali metal compounds is included. (P.C.H.)

26752 (RFP-765) ELECTRON MICROPROBE ANALYSIS OF PLUTONIUM–GALLIUM ALLOYS. Harvey, M. R.; Riefenberg, D. H. (Rocky Flats Div., Dow Chemical Co., Golden, Colo.). May 16, 1966. Contract AT(29-1)-1106. 11p. (CONF-660518-1). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From AEC Annual Metallography Meeting, Denver.

A calibration curve of relative intensity versus gallium concentration was obtained on a series of plutonium-gallium alloys. The concentration range studied was 0.56 to 2.12 wt %. The relative intensity was found to vary linearly with concentration in this range. Based on the standard deviations observed in this work, 19 determinations were required for an accuracy of ±0.05 wt % absolute at a confidence level of 99%. (auth)

26753 (Y-MA-732) A PROCEDURE FOR PRODUCING LITHIUM FLUORIDE FOR THE ORNL EXPERIMENTAL GAS-COOLED REACTOR. Brotherton, R. P. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). May 6, 1966. Contract W-7405-eng-26. 3p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

A procedure for producing lithium fluoride from lithium hydroxide by reaction with hydrofluoric acid is outlined. Precautions necessitated by the reactivity of hydrofluoric acid are given. (M.O.W.)

26754 SIMULTANEOUS DETERMINATION OF COPPER AND ZINC IN HUMAN LUNG TISSUE BY NEUTRON ACTIVATION ANALYSIS. Keenan, Robert G.; Marcus, Judith H.; Devoe, James R. (National Bureau of Standards, Washington, D. C.). Amer. Ind. Hyg. Ass. J., 27: 128-34(Mar.-Apr. 1966).

A split-standard technique is described for estimating the chemical yields of rapid two-step radiochemical separation procedures which have been applied to the ^{64}Cu and ^{69m}Zn isotopes produced in 125 mg portions of dried human lung samples as the result of 30-minute irradiations in a thermal neutron flux of 10^{13} n/cm^2-sec. The separated radioactivities are counted by using a 400-channel pulse-height analyzer and a 5-inch by 4-inch single NaI(Tl) crystal. The relative standard deviations for a set of five replicate determinations were 2.9% for copper and 5.7% for zinc. (auth)

26755 QUANTITATIVE X-RAY SPECTROGRAPHIC DETERMINATION OF TRACES OF ELEMENTS USING DIRECT ELECTRON EXCITATION. Toussaint, C. J.; Vos, Gilbert (EURATOM, Ispra, Italy). Anal. Chem., 38: 711-14(May 1966).

An x-ray spectrographic method using direct electron excitation for quantitative determination of traces of a

number of elements in different matrices is described. Limits of detection are reported for Zn, Cu, Si, and Mg in aluminum, Co in low alloy steel, P in bronze, and Na in a graphite matrix. The results are compared with those obtained by other methods. Factors affecting further improvements in the sensitivity limits of low atomic number elements are discussed. (auth)

26756 RADIOMETRIC METHOD FOR DETERMINATION OF IODIDE IN NATURAL WATERS. Richter, H. G. (Commissariat a l'Energie Atomique, Grenoble, France). Anal. Chem., 38: 772-4(May 1966).

A method for measuring microgram iodide concentrations in natural waters is described. It is based on the principle that if a benzene solution of radioiodine of known specific activity is shaken with an aqueous solution of iodide, the radioactivity will distribute itself between the two phases in direct proportion to the mass of iodine or iodide present in the individual phases. A known quantity of ^{131}I is added to the sample containing the unknown amount of iodide. After oxidation to iodine and extraction into benzene, the radioactive species is then equilibriated with a known quantity of inactive iodide ion. The quantity of iodine in the final benzene phase is computed from the ratio of activities in the two phases and the known quantity of iodide added to the aqueous phase. The best recovery of iodine obtained was 87%. The limit of sensitivity of the procedure is set by the level of impurities in the reagents. The reproducibility of the procedure developed is less than ±10% at the 5-mg-of-iodine-per-liter concentration. Data on the accuracy of the procedure are given. The problems of interferences are discussed. (F.J.H.)

26757 DETERMINATION OF FISSION-PRODUCT XENON DISTRIBUTION IN URANIUM CERAMICS BY ISOTOPE DILUTION AND MASS SPECTROMETRY. Crocker, I. H.; Hart, R. G. (Atomic Energy of Canada, Ltd., Chalk River, Ont.). Anal. Chem., 38: 781-3(May 1966).

A method was developed for determining the distribution of stable fission-product xenon in highly irradiated UC or UO_2 fuel elements that is accurate to ±3%. The samples are taken from precisely selected sites. The exact location of each site is recorded on Polaroid film. Isotope dilution and mass spectroscopy techniques were used in the analyses. The analysis of five UO_2 drill cores, 1.3 mm in dia and 48 mm long that were irradiated under as similar conditions as possible, gave an average result of 0.206 ± 0.005 ml STP xenon per gram of uranium. The relative standard deviation was ±2.6%. The result agreed with the concentration of fission product xenon calculated from ^{235}U depletion measurements, which was 0.205 ± 0.012 ml STP per gram of uranium. Volumes smaller than 1×10^{-2} ml cannot be handled routinely in the mass spectrometer, so that 8×10^{-5} ml of fission product xenon is the lower limit of the method as described. Examples of the application of the method in determining the detailed radial distribution of fission product xenon in UO_2 fuel elements are given, where the concentrations of fission product xenon are plotted against calculated operating temperatures within each of three UO_2 fuel pellets. (F.J.H.)

26758 DETERMINATION OF ^{48}Ca IN NATURAL CALCIUM BY NEUTRON ACTIVATION ANALYSIS. Corless, James T. (Univ. of Rhode Island, Kingston). Anal. Chem., 38: 810-13(June 1966). (NYO-3369-8).

An analytical method for determining the ratio of ^{48}Ca to total Ca in natural materials relative to that of a reference standard employs precision neutron activation analysis and an EDTA weight titration of separated and purified Ca. Data illustrate the applicability of the method to the detection of variations in the relative isotopic abundance of ^{48}Ca. (auth)

26759 APPLICATION OF LITHIUM-DRIFTED GERMANIUM GAMMA-RAY DETECTORS TO NEUTRON ACTIVATION ANALYSIS. NONDESTRUCTIVE ANALYSIS OF A SULFIDE ORE. Lamb, J. F.; Prussin, S. G.; Harris, J. A.; Hollander, J. M. (Univ. of California, Berkeley). Anal. Chem., 38: 813-18(June 1966). (UCRL-16600).

Lithium-drifted germanium gamma spectrometers were used for nondestructive analysis of a sulfide ore by neutron activation. The concentrations of ten elements were determined in the range from 1.8×10^5 ppM (iron) to 2.0 ppM (gold). The analytical sensitivity obtained with available Ge(Li) detectors was compared with sodium iodide scintillators for estimation of manganese in the ore. The various detector properties which affect sensitivities are discussed. (auth)

26760 REACTOR NEUTRON ACTIVATION ANALYSIS. INSTRUMENTAL SENSITIVITIES IN SIX MATRIX MATERIALS. Yule, Herbert P. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Anal. Chem., 38: 818-21(June 1966).

Radioactivation of major, and sometimes minor, sample constituents often precludes the possibility of instrumental neutron activation analysis for desired trace elements, even though their anticipated concentrations are well above known detection limits. Knowledge of sample composition may be inadequate for accurate prediction of feasibility of the analysis. One way to overcome this difficulty is to assemble data on elemental detection limits in various matrices. Experimentally determined matrix sensitivities of over 65 elements in six matrix materials commonly encountered in activation analysis are presented. The results enable the feasibility of a particular analysis in one of these materials to be determined. (auth)

26761 INTERMOLECULAR ENERGY TRANSFER AS A MEANS OF CHEMICAL ANALYSIS. SENSITIZATION OF RARE EARTH EMISSION IN DILUTE SOLUTION BY AROMATIC CARBONYL COMPOUNDS. McCarthy, W. J.; Winefordner, J. D. (Univ. of Florida, Gainesville). Anal. Chem., 38: 848-53(June 1966).

The fluorescence emission of terbium, europium, samarium, and dysprosium ions is selectively sensitized by various aromatic carbonyl compounds. The system is excited by monochromatic light at the wavelength of maximum absorption for the phosphorescence transition of the carbonyl compound, and emission is measured at the wavelength corresponding to the rare earth ion emission line. The influence of donor-acceptor concentration on the emission intensity of the rare earth ion was studied, and limits of detection for the rare earths are given. An empirical equation was developed to facilitate prediction of sensitization by a specific aromatic carbonyl compound for a specific rare earth. The analytical possibilities of this phenomenon are discussed with regard to sensitivity, selectivity, and speed of analysis and other analytically important considerations. (auth)

26762 DETERMINATION OF DISSOLVED ^{210}Po IN WATER BY COPRECIPITATION WITH TELLURIUM BY STANNOUS CHLORIDE. Rushing, D. E. (Department of Health, Education, and Welfare, Salt Lake City). Anal. Chem., 38: 900-5(June 1966).

The efficient coprecipitation of ^{210}Po with Te by stannous chloride was applied to the determination of ^{210}Po in water. The Te–^{210}Po precipitates are alpha counted on 0.22-μ membrane filters. A short-cut single-precipitation method is also given. Methods were tested at six levels of ^{210}Po activity (0.06 to 1636 pC per liter); in this range, the weighted average recovery was 98.8% for both methods. Radiochemical specificity was very good; there were no interferences from stable substances in samples whose compositions approached drinking water standards. The methods have sufficient sensitivity to permit their use in the determination of ^{210}Pb in water by ^{210}Po ingrowth. (auth)

26763 SIMPLE AND ACCURATE CALIBRATION MODEL FOR HYDROGEN-CONTENT, BETA-PARTICLE TRANSMISSION GAGES. Gardner, Robin P.; Roberts, Kenneth F. (Research Triangle Inst., Durham, N. C.). Anal. Chem., 38: 923-5(June 1966).

Comparison of results obtained from different calibration models for measuring hydrogen weight fractions using beta-particle transmission and backscatter gages for the analysis is discussed. The mathematical equations proposed for the calculation of hydrogen content are given. The calibration model proposed does not require a trial-and-error analysis, and still gives an adequate fit of the

data. The model contains only 3 constants when background can be neglected or obtained experimentally, and these constants can be determined by a straightforward least-squares analysis. (F.J.H.)

26764 TRACE IMPURITY ANALYSIS OF PLUTONIUM–URANIUM–ZIRCONIUM ALLOYS BY ANION EXCHANGE-PARTITION CHROMATOGRAPHY. Huff, Edmund A.; Kulpa, Stanley J. (Argonne National Lab., Ill.). Anal. Chem., 38: 939-40(June 1966).

The procedure for determining trace metal impurities in ternary plutonium–uranium–zirconium alloys by anion exchange-partition chromatography is described. The accuracy and precision of the proposed separation procedure were determined by repeated analyses of ternary plutonium–uranium–zirconium alloy. Quantitative recoveries of five common impurities were verified by the densitometric copper spark method, using cobalt as an internal standard. An organic phase with the composition of 95% tri(2-ethylhexyl)phosphate–5% di(2-ethylhexyl)hydrogen phosphate was used as the stationary extraction phase. Results are presented for Al, Cr, Fe, Mn, and Ni impurities in the alloys. (F.J.H.)

26765 HIGH SENSITIVITY OXYGEN ANALYSIS OF METALLIC SAMPLES WITH FAST NEUTRONS. Benjamin, Richard W.; Blake, Kenneth R.; Morgan, Ira L. (Texas Nuclear Corp., Austin). Anal. Chem., 38: 947-9 (June 1966).

Use of fast neutron activation analysis for measuring oxygen in concentrations below 10 ppM in cylindrical metallic samples is described. Oxygen analysis may be done accurately and rapidly with the $^{16}O(n,p)^{16}N$ reaction. The entire system is automatically programmed to irradiate, transfer to detector, and count the sample for a predetermined time. Results of some measurements are given. (F.J.H.)

26766 DETERMINATION OF ZINC BY SUBSTOICHIOMETRIC ISOTOPE DILUTION. Ballaux, C.; Dams, R.; Hoste, J. (Ghent Univ.). Anal. Chim. Acta, 35: 141-7 (June 1966).

Ruzicka et al. previously proposed a determination of zinc in highly pure germanium dioxide by a substoichiometric extraction technique. The effects on the substoichiometric extraction of equilibrium time, pH, and interfering ions were investigated by radioactive tracer techniques and spectrophotometric measurements. The sensitivity of the procedure was limited by the blanks and the addition of oxalate ions can give rise to inaccurate results. The specific activity of ^{65}Zn was also determined by substoichiometric extraction. (auth)

26767 DETERMINATION OF ZINC IN HIGH-PURITY BISMUTH BY THERMAL NEUTRON ACTIVATION. Kim, J. I.; Hoste, J. (Ghent Univ.). Anal. Chim. Acta, 35: 148-53(June 1966).

A neutron activation analysis for determination of zinc in bismuth was developed. After irradiating the samples for 44 days at 4×10^{11} n/cm^2/sec, zinc was separated quantitatively by hexone extraction and precipitation as quinaldate. The sensitivity of the method was estimated as 0.05 ppm. No zinc could be detected in the high-purity bismuth samples. An additional method of analysis showed that the precision was 1.2%. (auth)

26768 RAPID RADIOCHEMICAL PROCEDURE FOR INDIUM. Sam, Daniel; Love, Daniel L. (Naval Radiological Defense Lab., San Francisco). Anal. Chim. Acta, 35: 154-61(June 1966).

A rapid radiochemical procedure was developed for the separation of indium radionuclides from a mixed fission-product solution. An alcoholic pyridine solution is added to a uranium solution containing indium and tin carriers. The resulting tin precipitate is separated from the indium-containing solution by filtering through a cellulose membrane filter. The decontamination factor for tin is 2×10^3. Other fission products are only partially removed. The chemical yield of indium is about 44%, and the time required for the separation is about 10 sec. After the tin-separated indium has decayed, the tin daughters of indium are removed from all the other fission products at a specified time and measured, so that the amount of indium present at the time of the tin precipitation is determined. (auth)

26769 RAPID RADIOMETRIC DETERMINATION WITH EDTA INVOLVING BACK TITRATION. Mueller, K. (Technische Hochschule, Graz). Anal. Chim. Acta, 35: 162-8(June 1966). (In German).

The principle of back-titration with EDTA was applied to rapid radiometric methods. A suitable vessel for performing the reaction, filtration, and count-rate measurement is described. The optimal conditions for use of solid $^{110m}AgIO_3$ as indicator were studied: the time for solubility-equilibrium of solid silver iodate, the reaction time of EDTA with silver iodate, and the pH-dependence of the silver–EDTA reaction rate. Procedures are given for calibration curves and for rapid radiometric determinations of copper(II), nickel(II), lead(II), and zinc(II). The method is suitable for the range from 1 to 100 μg. (auth)

26770 DETERMINATION OF HYDROGEN, NITROGEN, AND OXYGEN IN URANIUM MONOCARBIDE. Colombo, A.; Serrini, G. (EURATOM-CCR, Ispra, Italy). Anal. Chim. Acta, 35: 169-80(June 1966). (In French).

A method is described for determination of hydrogen, oxygen, and nitrogen in uranium monocarbide. Hydrogen and oxygen are determined by the classical or modified "platinum flux" method at 2000°C with a coefficient of variation of 10%. Nitrogen is determined at 2000°C by modification of the "platinum flux" technique. The results obtained were in agreement with those found by Kjeldahl analysis. The coefficient of variation was about 10%. A procedure for the simultaneous determination of the 3 gases is given. (auth)

26771 DETERMINATION OF ZIRCONIUM, THORIUM, AND SCANDIUM WITH 2,5-DIHYDROXY-1,4-BENZOQUINONE. Singhal, S. P.; Ryan, D. E. (Dalhousie Univ., Halifax, Nova Scotia). Anal. Chim. Acta, 35: 195-9(June 1966).

Zirconium is quantitatively precipitated by 2,5-dihydroxy-1,4-benzoquinone and is separated from scandium in 1N hydrochloric acid solution. Thorium is separated at pH 0.5 from uranium(VI), cerium(IV), lanthanum, yttrium, and scandium. Scandium is quantitatively precipitated by this reagent in the pH range from 1.4 to 2.0 and at pH 1.5. Equivalent amounts of lanthanum do not interfere; small amounts of yttrium cause interference. (auth)

26772 DETERMINATION OF WATER IN BERYLLIUM OXIDE. Smythe, L. E.; Whateley, T. L. (Australian Atomic Energy Commission Research Establishment, Sydney). Analyst, 91: 285-7(Apr. 1966).

The three methods were investigated for determining water content of beryllium oxide: infrared spectrophotometry of the oxide as a mull; exchange with deuterium oxides; and reaction with 2,2-dimethoxypropane. All these methods have an infrared finish. The exchange with deuterium was found to be the most accurate method of the three and also the most sensitive to small amounts of water. All three methods gave satisfactory results. (F.J.H.)

26773 EFFECT OF PARTICLE SIZE ON BACK-SCATTERED X-RAY CORRECTION METHODS IN ON-STREAM X-RAY FLUORESCENCE ANALYSIS. Carr-Brion, K. G. (Warren Spring Lab., Stevenage, Eng.). Analyst, 91: 289-90(Apr. 1966).

Effects of particle size on back-scattered x-ray intensity and correction methods for on-stream analysis are described. Changes in the composition and content of the solid components in the slurry should be considered. It is shown that the fluorescent x-ray intensity from particles decreases as the particle size increases. It was found that the fluorescent intensity from the reference block, cadmium, increased with increasing particle size in the haematite-water slurry, while the fluorescent iron K_α intensity from the particles in the slurry decreased. Even if separate means of correcting for real changes in solid content are incorporated, the use of back-scattered radiation will not compensate for particle-size effects. (F.J.H.)

26774 DETERMINATION OF THE OXYGEN CONTENT OF STEEL AND METAL POWDERS WITH 14.5 Mev NEUTRONS. Nickel, Hubertus; Rottmann, Johannes; Stocker, Hans-Jochen; Koester-Pflugmacher, Annelore; Frohberg, Martin G. Arch. Eisenhuettenw., 35: 637-47(July 1964). (In German).

This method, based on neutron activation, gives in a very short time (2 to 3 min) reliable results and is very sensitive and precise. The reaction, $^{16}O(n,p)^{16}N$, was used because the reaction product, ^{16}N, produced extremely energetic γ quanta (6.13 and 7.13 Mev) that could be detected readily by γ spectroscopy. The cross section of this reaction was rather low and the reaction could be produced only by very powerful neutrons of at least 14.5 Mev energy. Since the O content of steel ranges from 0.001 to 0.15%, a 50-g sample may contain from 0.5 to 75 mg. Fast neutrons produced other activities in steel and especially in steel alloys, but the advantage of the method is that the energy of the ^{16}N produced surpassed that of all of the other activation products. Also, with the short half life of ^{16}N (7.4 sec), a neutron bombardment of 1 min produced a saturated activity. The use of larger samples eliminated inhomogeneities of O distribution. It was indicated that a satisfactory linearity existed between the O content and the saturated activity. The sensitivity of the O determination was 10 ppM. (OID)

26775 RESEARCH OF TRACES AND ULTRA-TRACES OF ELEMENTS. Monnier, Denys (Univ., Geneva). Arch. Sci. (Geneva), 18: 273-81(May-Aug. 1965). (In French).

Chemical methods to remove elements that produce long-lived isotopes interfering with neutron activation analysis of short-lived isotopes is described. An application of the technique is found in extraction before activation analysis of Co in 18/8 samples, in which ^{60m}Co is produced. A small amount of ^{60}Co is introduced into the sample to serve as standard for the spectrometric measurement. On the other hand, V in 18/8 may be analyzed without interference of any other ions; but its half life is so short (3.76 min) that special formulas were developed to allow analysis. Data are collected and compared against nomographs constructed for the technique, which allow determination of the relations between activity found, relative saturation activity, saturation factor, and decay factor, so that optimum time at beginning of a count may be determined. (BBB)

26776 THE ESCA METHOD USING MONOCHROMATIC X-RAYS AND A PERMANENT MAGNET SPECTROGRAPH. Fahlman, A.; Siegbahn, K. (Univ. of Uppsala). Ark. Fys., 32: 111-29(1966).

A semicircular, permanent magnet spectrograph with a pole diameter of 600 mm and a pole gap of 29 mm was constructed. The maximum field in the pole gap is 250 gauss, which allows an analysis of electrons up to the 1 Mev region. The spectrograph is equipped with a monochromatic radiation source consisting of an x-ray tube and a bent crystal. Two sets of radiation sources are available giving $CuK\alpha_1$ radiation respectively. An evaporation chamber, attached to the spectrograph, permits one to place a specimen in the source position after an evaporation without exposing it to a pressure higher than 10^{-6} torr. The combination of a semicircular spectrograph and an x-radiation source can be used for electron spectroscopic studies according to the ESCA method. Electrons ejected by the x-ray beam have a low energy and are detected by means of a nuclear research emulsion after the magnetic analysis. The photographic plate is analyzed by counting the individual electron tracks in a microscope. The apparatus was applied to electron spectroscopic studies of organic compounds containing sulfur, viz. sodium benzyl penicillinate and sodium dextran sulfate. From the shifts of the K level energies of sulfur it was possible to assign oxidation numbers to the sulfur in accordance with the structural formulas. The relative abundances of sodium and sulfur in the two organic compounds could be determined from the intensities of the recorded electron lines. These ratios are compared to those obtained from the structural formulas and the agreement is within 5% in both cases. (auth)

26777 CHROMATOGRAPHIC METHOD FOR RADIOCHEMICAL ANALYSIS OF REACTOR PRIMARY COOLING SYSTEM. Saikov, Yu. P. At. Energ. (USSR), 20: 123-6 (Feb. 1966). (In Russian).

A chromatographic method for the radiochemical analysis of the water of the primary circuit is described. It is bases on the utilization of ionite KU-2 and hydrochloric acid of continually varying concentrations. With this method, it is possible within 3 to 4 hrs to separate Np, Na, Se, Ba, the rare-earth elements Zr and Nb, and also the two groups I, Br, Te, Mo, Sb, Ru, and Rh from Fe, Cr, Ni, Cu, and Cs. (tr-auth)

26778 ANALYSIS OF GASES DISSOLVED IN WATER OF PRIMARY COOLING SYSTEMS OF VVR-M REACTORS. Trenin, V. D. At. Energ. (USSR), 20: 167-8(Feb. 1966). (In Russian).

An apparatus for gas chromatographic analysis of gases dissolved in the water of the primary cooling systems of the VVR-M reactors is described. (G.O.Y.)

26779 URANIUM CONTENT IN SULFIDES AS INDICATOR OF URANIUM MINERALIZATION. Baranov, E. N.; Vertepov, G. I. At. Energ. (USSR), 20: 170-1(Feb. 1966). (In Russian).

The uranium content of sulfides from various multimetal deposits was determined using the luminescence method with preliminary chemical processing of the samples. The results of microradiographic analyses showed that the high uranium concentration (higher than 0.01%) is due to the microaddition of uranium mineral (mainly through oxidation). (G.O.Y.)

26780 APPARATUS FOR NEUTRON ACTIVATION ANALYSIS. Egiazarov, B. G.; Karpukhin, O. A.; Matveev, V. V. At. Energ. (USSR), 20: 252-6(Mar. 1966). (In Russian).

Some equipment for neutron activation analysis in both mobile and stationary laboratories is described. A system for connecting the individual units of the complex to permit automatic analyses is outlined. (D.C.W.)

26781 AMPEROMETRIC TITRATIONS OF THORIUM WITH ALKALI TUNGSTATE. Gupta, C. M. (Univ. of Rajasthan, India). Bull. Chem. Soc. Jap., 39: 837-8(Apr. 1966).

Amperometric titrations of thorium with alkali tungstate are described. The nature of the reduction wave produced by Th^{4+} was investigated. The accuracy and reproducibility of the titrations were found to be satisfactory, even at low concentrations of thorium salt (1mM) or alkali tungstate. Direct and reverse pH titrations showed a sharp break at the 1 : 2 (Th : W) ratio. The pH titrations indicated a sharp change in pH value from the acidic to the neutral side of the end point. The possibility of estimating metal thorium within a 2% error was suggested from the titrations. (F.J.H.)

26782 UTILIZATION OF ACTIVATION ANALYSIS IN THE STUDY OF SILICATES. Perdijon, J. (Societe Anonyme de Machines Electrostatiques, Grenoble, France). Bull. Soc. Franc. Ceram., No. 67, 45-51(Apr.-June 1965). (In French).

A method permitting the rapid nondestructive determination of a great number of elements in silicates is described. An industrial set-up putting the principle of activation analysis into practice is described and an example of an analysis is given. A table shows the degree of accuracy that can be attained at present with this system. Thus, with the accelerator described operating at 150 kv, elements which can be estimated with 14-Mev neutrons at a sensitivity of 1 to 10 μg are Ba, Br, Cu, F, Pr, and Si; 10 to 100 μg, Ag, Al, Cr, Fe, Ga, Ge, K, N, Na, O, P, Sb, Se, Zn, and Zr; 100 to 1000 μg, As, Ce, Cl, Co, Gd, Hf, Hg, Mg, Mo, Nb, Pd, Pt, Rb, Ru, S, Sc, Sn, Sr, Ta, and W; 1000 to 10,000 μg, B, Ni, Pb, Te, Ti, Tl, and Y. Other elements that can be determined by thermal (rather than 14-Mev) neutrons which can be generated by the accelerator, are described and illustrated. (BBB)

26783 DETERMINATION OF TRACES OF SAMARIUM AND EUROPIUM IN HIGHLY PURIFIED GRAPHITE BY

EMISSION SPECTROGRAPHIC ANALYSIS. Osawa, Hisao (Fuji Electric Co. Ltd., Yokosuka, Japan). Bunseki Kagaku, 15: 342-7(Apr. 1966). (In Japanese).

A method for determining traces of samarium and europium in highly purified graphite applicable to the range from 0.10 to 0.90 ppM and from 0.06 to 0.24 ppM, respectively, was established on the basis of an emission spectrographic procedure. Standard samples were prepared with highly purified graphite, samarium oxide or europium oxide, 0.2 ppM of silver chloride, and 0.2 ppM of auric chloride as internal standard elements for samarium and europium, respectively, and 2% sodium fluoride as a spectrographic buffer substance. A d-c arc technique was used to excite the elements. The experimental conditions for excitation were 280 v, 21 amp, analytical gap of 5 mm in argon atmosphere, and an exposure time of 60 or 90 sec for samarium or europium. The intensity ratios of Sm: 3306.35 Å/Ag: 3280.68 Å, Eu: 2823.94 Å/Au: 2675.95 Å were found to be proportional to the samarium and europium contents and were used for the determination. The standard deviation in this method was below 14%. (auth)

26784 SIMPLE IMMERSION DEVICE FOR MEASUREMENT BY β-RAY BACK SCATTERING. Krivan, V. (Inst. of Chemical Technology, Bratislava). Chem. Zvesti, 18: 872-4(1964).

A device for analysis of suspensions and solutions is described. A lead-shielded ring-shaped source is used. (Analytical Abstr.)

26785 DETERMINATION OF GOLD IN MINERAL RAW MATERIALS BY MEANS OF NEUTRON ACTIVATION ANALYSIS. Stefanov, G. (Geologiya i Okhrana na Zemite Nedra, Sofia. Slovenska Vysoka Skola Technicka, Bratislava). Chem. Zvesti, 18: 661-8(Sept. 1964). (In Slovak).

A method was worked out for determination of gold in silicate samples by means of activation analysis. The samples were exposed to a neutron flux of 2.4×10^{13} n/cm^2/sec in a nuclear reactor. A radiochemical separation method was used for the isolation of ^{198}Au radionuclides [^{197}Au(n,γ)^{198}Au]. The induced activity was measured with a 400-channel scintillation γ spectrometer or a B-2 radiometer. By using this method, it is possible to determine gold in crude ores and in other raw materials in amounts as low as 2.8×10^{-10} g. (OID)

26786 CHROMATOGRAPHIC SEPARATION AND DETERMINATION OF ^{51}Cr, ^{54}Mn, ^{60}Co, AND ^{59}Fe. Fojtik, M.; Koprda, V. (Research Inst. of Industrial Hygiene and Occupational Diseases, Bratislava). Chem. Zvesti, 20: 180-7(1966). (In Czech).

A method was developed, which permits separation and determination of small quantities of ^{51}Cr, ^{54}Mn, ^{60}Co, and ^{59}Fe, by paper chromatography using Whatman 1 chromatographic paper and an acetone–7N HCl (90: 10) solvent system. A separation with the following R_F-values was attained: Cr 0.03, Mn 0.32, Co 0.69, and Fe 0.96. The R_F-values were chiefly independent of isotopic carrier amount. Quantitative determination was carried out by means of planimetric evaluation of radiographic records. The determination threshold of the method is 1.70 nC for ^{51}Cr, 0.36 nC for ^{54}Mn, 0.12 nC for ^{60}Co, and 0.18 nC for ^{59}Fe, and the relative errors in determination of 8 nC of each radioisotope are 13.0, 8.5, 2.3, and 10.6%, respectively. After preliminary sample treatment the method proved suitable for determination of these radioisotopes in biological materials. (auth)

26787 MINOR ELEMENTS IN IGNEOUS AND METAMORPHIC APATITE. Cruft, E. F. (Univ. of New Mexico, Albuquerque). Geochim. Cosmochim. Acta, 30: 375-98 (Apr. 1966).

Analyses of forty-six apatites from various igneous and metamorphic environments have shown enrichment relative to the lithosphere in Ce, Y, La, and Sr; apatite from many granite pegmatites is also enriched in Mn. These elements appear to be substituting for Ca in the structure. The P position is far less amenable to impurity incorporation, and As^{5+} and V^{5+} seldom substitute to any degree for P^{5+}; this is partly due to environmental and partly to structural control. The ratio of Y to Ce + La is higher, and total Ce + La + Y content lower, in pegmatite apatites than in apatite from regional metamorphic and plutonic environments, because of selective incorporation of the Ce-earths in K-felspars and monazite during crystallization of granites and pegmatites, and enrichment of the Y-earths in residual solutions. The highest Sr content occurs in apatite from ultrabasic and alkalic rocks. Ba is also enriched in apatite from alkalic complexes and carbonatites. (auth)

26788 ACTIVATION DETERMINATION OF Ce, Eu, Sc, Ba, U AND P IN DARK AND LIGHT VARIETIES OF THE CHONDRITES KUNASHAK AND PERVOMAISKI POSELOK. Lavrukhina, A. K.; Kolesov, G. M.; Kalicheva, I. S.; Akolzina, L. D. (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Moscow). Geokhimiya, No. 3, 281-90(Mar. 1966). (In Russian).

The content of Ce, Eu, and Sc in undivided magnetic and nonmagnetic fractions of dark and light varieties of the hypersthenic chondrites Kunashak and Pervomaiski Poselok and the content of Ba, U, and P in dark and light varieties of the meteorite Kunashak were determined by the method of neutron activation using a specially developed technique. The abundances of Eu, Sc, Ba, and U in both varieties were practically the same; the content of Ce was higher and correlated with the higher concentrations in light varieties of the investigated chondrites, of MnO, Cr_2O_3, and FeO and with the lower concentration of metallic iron in them at an equal general content of iron and FeS. Anomalies in the content of primary rare gases, volatile elements, and elements with high reduction-oxidation potentials as well as in the age of rare gas retention are connected with the process of thermal evolution of the meteoritic material. (auth)

26789 PURITY CONTROL OF PALLADIUM AND GOLD TARGETS USED FOR PRODUCTION OF RADIOISOTOPES. Abdel-Rassoul, A. A.; Fouad, H. (Atomic Energy Establishment, Cairo). Int. J. Appl. Radiat. Isotop., 17: 309-12(May 1966).

The quantitative determination of certain metallic impurities in gold and palladium targets used in the production of carrier-free ^{111}Ag and of ^{198}Au for medical preparations is carried out by neutron activation techniques. The radiochemical procedures and counting technique are described. The presence of gold and silver in palladium was verified by analyzing the gamma scintillation spectrum from neutron-irradiated palladium samples. Gold was identified by the decay of the 0.411-Mev photopeak in the measured spectrum. The presence of silver was determined in pile-irradiated targets by decay measurements and by γ spectrometry. The analytical data obtained for silver in gold are given. (F.J.H.)

26790 METHOD OF ISOTOPIC ANALYSIS OF OXYGEN IN MICROQUANTITIES OF WATER. DETERMINATION OF EQUILIBRIUM DISTRIBUTION COEFFICIENTS OF ^{18}O BETWEEN H_2O AND CO_2 AND D_2O AND CO_2. Majzoub, Mustapha (CEN, Saclay, France). J. Chim. Phys., 63: 563-8(Apr. 1966). (In French).

A method was developed for the preparation of carbon dioxide from microquantities of water for oxygen isotope analysis by mass spectrometry. Water is reduced on a very pure graphite rod heated between 1,100 and 1,200°C to obtain carbon monoxide and hydrogen. Hydrogen is removed by diffusion through a palladium tube and by pumping. Carbon monoxide is converted to carbon dioxide on a nickel catalyst. The precision of the method is ±0.2 per mil. The method was applied in determinations of the equilibrium distribution coefficients of ^{18}O at 25°C for the H_2O-CO_2 and D_2O-CO_2 systems. The values found are 1.0417 for the H_2O-CO_2 system and 1.0236 for the D_2O-CO_2 system. (auth)

26791 ELECTROPHORESIS OF RADIONUCLIDES ON CELLOGEL. Aitzetmueller, K.; Buchtela, K.; Grass, F. (Oesterreichische Hochschule, Vienna). J. Chromatog., 22: 431-45(May 1966). (In German).

A method for the electrophoresis of inorganic radioactive

cations on cellulose acetate (Cellogel) is described. The advantages of this technique are illustrated by numerous examples. Separations of the rare earth metals, the alkaline earths, and fission products are mentioned particularly. (auth)

26792 POLAROGRAPHY OF NEODYMIUM, SAMARIUM, YTTERBIUM, AND EUROPIUM IN ACETONITRILE. Cokal, E. J.; Wise, E. N. (Univ. of Arizona, Tucson). J. Electroanal. Chem., 11: 406-15(June 1966).

Polarographic determination of europium, neodymium, samarium, and ytterbium in their mixtures is described. The polarographic waves correspond to the reduction of the tripositive ions to dipositive ions. Water and traces of acid interfer, but their effect can be made negligible by adding an excess of nonreducible rare earths. The half-wave potential of the Sm(II)-(O) polarogram in acetonitrile was found to be −1.55 v vs the aqueous SCE. (F.J.H.)

26793 ABSOLUTE ISOTOPIC ABUNDANCE RATIOS AND THE ATOMIC WEIGHT OF A REFERENCE SAMPLE OF CHROMIUM. Shields, William R.; Murphy, Thomas J.; Catanzaro, Edward J.; Garner, Ernest L. (National Bureau of Standards, Washington, D. C.). J. Res. Nat. Bur. Stand., 70A: 193-7(Mar.-Apr. 1966).

Absolute values were obtained for the isotopic abundance ratios of a reference sample of chromium, using surface emission mass spectrometry. Samples of known isotopic composition, prepared from nearly pure separated chromium isotopes, were used to calibrate the mass spectrometers. The resulting absolute values were $^{50}Cr/^{52}Cr$ = 0.051859 ± 0.000100, $^{53}Cr/^{52}Cr$ = 0.113386 ± 0.000145, and $^{54}Cr/^{52}Cr$ = 0.028222 ± 0.000059, yielding an atomic weight (^{12}C = 12) of 51.99612 ± 0.00033. The indicated uncertainties are overall limits of error based on 95% confidence limits for the mean and allowances for effects of known sources of possible systematic error. (auth)

26794 RECORDER CHART-TO-PUNCHED CARD CONVERTER AND COMPUTER PROGRAM FOR ISOTOPIC ANALYSIS BY MASS SPECTROMETRY. Cassie, G. E.; Cuthbert, J.; Silk, C. (Atomic Energy Research Establishment, Harwell, Eng.). J. Sci. Instrum., 43: 283-8(May 1966).

Spectra from a thermal ionization mass spectrometer used for isotopic analysis of solids are recorded on a 10-in. pen recorder chart. An inexpensive semi-automatic measuring device was made for quickly converting this spectrum into peak heights punched on computer cards. A computer program calculates the isotopic analysis both as the percentage abundances of each isotope and as the ratios of all except one to a predetermined reference isotope. Statistical analysis based on student's t distribution is provided, with further information of interest to the production of isotopes in electromagnetic separators. (auth)

26795 NEW AUTOMATIC METHOD FOR DETERMINING THE FALLING TIME OF DROPS IN THE ISOTOPIC ANALYSIS OF WATER. Pascalau, M.; Blaga, L.; Blaga, L. (Inst. for Atomic Physics, Cluj). J. Sci. Instrum., 43: 310-13(May 1966).

An apparatus is described which automatically records falling time in the isotopic analysis of water by the falling drop method. Sources of error are discussed in relation to the accuracy of determination of density from which concentrations of natural isotopes in water are derived. (auth)

26796 DETERMINATION OF NATURAL URANIUM IN THE URINE BY MEANS OF α COUNTING. Zsoldos, Tibor; Csovari, Mihaly; Toth, Arpad; Nagy, Lajos (Ore Mining Co. of the Mecsek, Pecs, Hungary). Kiserl. Orv., 17: 625-33(Dec. 1965).

Methods are described for the determination of natural uranium in the urine. Following the initial preparation of the urine, the uranium can be extracted with a 10% ammonium carbonate solution of TBP. Following repeated extraction with a 10% ammonium carbonate solution, the sample remaining after distillation is prepared and its activity is measured with a low-background α counter. A 95 ± 3% recovery can be achieved. The toxicology of uranium compounds is discussed briefly, data on the maximal permissible concentration values of uranium in the urine are quoted, and the recommended MPC values are given. The effects of ammonium carbonate and nitric acid concentrations, the extraction time, and the number of extractions were investigated. The distribution of nitric acid between the aqueous and organic phases was studied and the optimal conditions of the method are described. (ATD)

26797 POSSIBLE DEVELOPMENT OF NEUTRON ACTIVATION ANALYSIS IN HUNGARY. Bujdoso, Erno; Hegedues, Dezsoe; Mathe, Ferenc; Nagy, Lajos Gyoergy; Oerdoegh, Maria. Magyar Kem. Lap., 21: 155-9(Mar. 1966). (In Hungarian).

An excerpt from the study compiled at the request of the Hungarian Atomic Energy Commission in January 1964 is presented. A decisive factor for the extensive application of neutron activation analysis is the availability of neutron sources of sufficient intensity and accessible to any of the institutions concerned. The sensitivities obtainable with the various types of neutron sources, with particular regard to neutron generators, are discussed and the main fields of application considered. (auth)

26798 NON-DESTRUCTIVE DETERMINATION OF TRACES OF SILVER IN PALLADIUM BY NEUTRON ACTIVATION ANALYSIS. Toerko, Janos. Magyar Kem. Lap., 21: 166-7(Mar. 1966). (In Hungarian).

Traces of silver were determined in palladium used as target material for the production of ^{111}Ag by non-destructive activation analysis. The amounts of silver in the palladium species investigated were 4.3 ppM and the accuracy of the determination proved to be about 10%. (auth)

26799 HIGH-SENSITIVITY FLUOROMETER. Csanky, L. Meres Automat., 13: 240-1(1965).

In the instrument described for fluorometric determination of small quantities of uranium, the specimen is illuminated with the light from a mercury-vapor lamp supplied by the a-c mains; fluorescent light is sensed by a photoelectron multiplyer. The signal yielded by the last diode is supplied through a three-stage amplifier to a phase-sensitive amplifier and a voltmeter with differential circuit. The electronic equipment is transistorized. The light source supplies 100 cps light impulses and the amplifier also receives 100 cps signals. Noises disturbing measurements were thus considerably reduced and the stability increased. The sensitivity of the system is variable in a broad range. After a starting time of 1 hr, errors of measurement are lower than 5% if the supply voltages of the light source and of the electronic system are stabilized. (Hungarian Tech. Abstr.)

26800 STUDIES ON THE SEPARATION OF RARE EARTH IONS BY ION EXCHANGE. 4. PREPARATIVE SEPARATIONS WITH LACTIC ACID. Mikler, J.; Auer-Welsbach, Helga; Bauernfeind, E. (Univ., Vienna). Monatsh. Chem., 97: 287-99(1966). (In German).

A method is described for the separation of the rare earth elements on a macro scale (60–70 g) by elution from Dowex 50 × 8 ion exchange columns (10 × 120 cm) with ammonium lactate solutions, taking into account the restrictions of solubility of the elements. Use of this method on a 65-g sample of oxides of the elements is outlined, the order of elution being Er, Ho, Y + Dy, Tb, Gd + Eu, Sm, Nd, and Pr. The column was in the NH_4^+ form. The efficiency of the eluting agent was enhanced in discrete steps by increasing the degree of neutralization at a constant total concentration of lactic acid (0.25M). The column runs and measurement of the distribution coefficients indicate that in the investigated range of total lactic acid concentration (0.17 to 0.40M) the elution behavior is determined by the product, total concentration of lactic acid times the degree of neutralization, irrespective of the present excess of free acid. Photometric estimation of the rare earth metal ions in the eluates with xylenol orange at 570 mμ is also described, and standard curves are given. (BBB)

26801 COMPLEX FORMATION BETWEEN RARE-EARTH METALS AND N-METHYLANABASINE-α′-AZO-β-NAPHTHOL {1-[3-(1-METHYL-2-PIPERIDYL)-2-

PYRIDYLAZO]-2-NAPHTHOL}. Dzhiyanbaeva, R. Kh.; Talipov, Sh. T.; Chaprasova, L. V.; Serova, A. P. Nauch. Tr., Tashkentsk. Gos. Univ., No. 263, 69-71(1964).

In a neutral medium this reagent forms colored complexes with rare earth metals, suitable for their photometric determination. Its complexes with Pr, Sm, Y, Gd, and Yb have maximum extinction at 550 mμ. Beer's law was obeyed with 50 to 125 μg of Sm, 50 to 150 μg of Pr or Gd, and 40 to 150 μg of Yb in 25 ml of solution. For determination of total rare earths the error is approximately ±2.5%. (Analytical Abstr.)

26802 GAMMA-RAY SPECTROMETRY USING COMPUTER LIBRARY OF SPECTRA. **Eldridge, James S. (Oak Ridge National Lab., Tenn.); Brooks, A. A. Nucleonics, 24: No. 4, 54-8(Apr. 1966).**

A collection of gamma-ray response functions was made for 42 radionuclides measured using a NaI(Tl) spectrometer. The digital data from the collection are the basis of a new assay system whereby data from the standard response functions can be inserted into an analyzer memory from punched paper tape (or another method of recall used), and selected regions of the standard spectra can be compared with the same region from an unknown sample. By using a normalizing factor an absolute disintegration rate can be assigned to the unknown sample, and it can be identified. Two computer programs in FORTRAN-FAP were developed for this study. The making of library standards, least-squares resolution, and the use of the library standards are discussed. (J.F.P.)

26803 MEASUREMENT OF ACTIVITY OF ^{14}C IN THE BIOLOGICAL MATERIAL BY THE LIQUID SCINTILLATION METHOD. Krzywanska, Emilia; Mendecki, Jozef. Nukleonika, 11: 29-34(1966). (In Polish).

The optimal conditions for measurement of the activity of ^{14}C in biological samples by the liquid scintillation method were determined. The samples were burned to CO_2, which was absorbed in different amines and, in this form, was introduced into the scintillator solution. (auth)

26804 TRANSFER OF ACTIVITIES FROM CONTAINER MATERIAL TO SAMPLE IN NEUTRON ACTIVATION ANALYSIS. **Brune, Dag (Aktiebolaget Atomenergi, Studsvik, Sweden). Radiochim. Acta, 5: 14-16(Mar. 1966).**

The amounts of the activities originating from polyethylene and quartz containers transferred to container surface due to the recoil effect in the thermal neutron-capture process, causing contamination of the sample, were estimated. The universal range-energy relation given by Lindhard and Scharff was applied in the calculations. For containers with impurities in the ppM region, the amounts of activities transferred because of this effect were found to be negligible. However, when the containers were rinsed with hydrochloric acid, activities were found to be extracted from depths of 10^{-3} and 10^{-4} cm in the polyethylene and the quartz materials, respectively, which in some cases necessitates corrections. (auth)

26805 DETERMINATION OF TRACE CONTENTS OF ^{232}Th IN STONES AND MINERALS BY NEUTRON ACTIVATION. **Staerk, H.; Turkowsky, C. (Technische Hochschule, Munich). Radiochim. Acta, 5: 16-18(Mar. 1966). (In German).**

A neutron activation method was worked out for determination of traces of thorium in geological materials. The nuclide chosen was the 22.4-min ^{232}Th. Samples were irradiated for 60 min behind a cadmium filter in a neutron flux of 2×10^{12}/sec/cm^2. Fast radiochemical separations in the presence of carrier thorium gave ^{232}Th in a radiochemically pure form. Activity measurements were taken on a β proportional counter ~50 min after irradiation. The method described has a sensitivity of 0.1 ppM Th/100 mg sample with an accuracy of ±3%. (auth)

26806 RAPID SEPARATION OF TECHNETIUM FROM FISSION PRODUCTS. **Goldstein, Gerald; Dean, John A. (Oak Ridge National Lab., Tenn. Univ. of Tennessee, Knoxville). Radiochim. Acta, 5: 18-20(Mar. 1966). (ORNL-P-1285).**

The solvent extraction of technetium, as the pertechnetate ion, with cyclohexanone was studied and proved to be an unusually rapid, efficient, and selective method of separation. This separation was applied in the determination of the number of fissions occurring in a short irradiation of uranium by measurement of ^{99m}Tc, and to the separation of ^{99}Tc from long-lived fission products for burnup analysis. (auth)

26807 USE OF THE LIQUID EXCHANGER "PC-Amin-KM sec" FOR DETERMINATION OF ^{131}I. **Zaduban, M.; Brutovsky, M.; Liptakova, G.; Banas, J. (Inst. for Experimental Biology, Czechoslovak Academy of Sciences, Kosice, Czechoslovakia). Radiochim. Acta, 5: 34-7(Mar. 1966). (In German).**

Liquid anion exchanger "PC-Amin-KM sec" in CCl_4 was used for the concentration and quantitative determination of ^{131}I from water or biological materials. The effects of competitive ions, pH value, iodide concentration, and phase volumes were studied. The ^{131}I activity was directly measured in a solution of the liquid exchanger. A specific activity around $9 \cdot 10^{-8}$ μC/ml was found after concentration of the ^{131}I by ion exchange. (auth)

26808 ESTIMATION OF ^{228}Ra IN MONAZITE AND THORIUM SAMPLES. **Iyer, R. H.; Jain, H. C.; Ramaniah, M. V.; Rao, C. L. (Atomic Energy Establishment, Trombay, India). Radiochim. Acta, 5: 56-7(Mar. 1966).**

^{228}Ra determination in monazite and thorium samples is described. The method consists of determination of ^{228}Ac in equilibrium with ^{228}Ra using $Fe(OH)_3$ as carrier. The value obtained for the ^{228}Ra content in monazite was in fair agreement with the value calculated from the thorium content and assuming equilibrium between ^{232}Th and its decay products. (F.J.H.)

26809 SPECTROPHOTOMETRIC DETERMINATION OF A SMALL QUANTITY OF STRONTIUM IN THE PRESENCE OF A LARGE AMOUNT OF CALCIUM: PROPOSAL OF A METHOD FOR CORRECTION OF THE INTERFERENCE. **Marro, Franco; Pelati, Laura (Univ., Parma, Italy). Rendic. Ist. Lombardo Sci. Lett., A95: 215-19(1961). (In Italian).**

A formula is given for the correction of interference due to calcium in the spectrophotometric determination of strontium in marine plankton ash. The plankton are ashed in a platinum crucible in sodium-potassium carbonate, which is then dissolved in nitric acid. Standards of pure Sr are prepared, and a constant, b, is calculated from the relation $T_{Sr} = b\,[Sr^{2+}]$, where T_{Sr} is the transmittance due to Sr at concentration $[Sr^{2+}]$. Similarly, using pure Ca standards the transmittance (T_{int}) from the interference of Ca is used to determine the constant c in the relation $T_{int} = c[Ca^{2+}]$. From these equations the effective Sr concentration, $[Sr^{2+}]_{eff}$, is calculated from the relation: $[Sr^{2+}]_{eff} = [Sr^{2+}]$ measured $- c/b[Ca^{2+}]$. Using a wavelength of 460 mμ and a slit width of 0.2 mm, the value of b = 5 and c/b = 0.0031. Examples of the use of this relation in measurement of small amounts of Sr in plankton ash are given. (BBB)

26810 EXAMINATION OF THE HEXAMETHYLENETETRAMINE PROCEDURE FOR SEPARATION OF THORIUM FROM RARE EARTHS AND FOR DETERMINATION OF THORIUM. **Berman, S. S.; Semeniuk, P.; Russell, D. S. (National Research Council, Ottawa). Talanta, 13: 837-46(June 1966).**

An examination was made of the efficiency of the gravimetric reagent hexamethylenetetramine in the separation of thorium from rare earths and in the determination of thorium. Losses to the filtrate, beaker, and filter paper were evaluated as well as the extent of rare earth and other contamination of the thorium hydroxide precipitate. When hydroxylamine was used as the reducing agent to keep cerium in the tervalent state, excellent separations were obtained. The efficacy of the reagent was offset by the loss of small amounts of thorium to the precipitation vessel, the scavenging properties of the precipitate for silica, and the difficulty in evaluating a true reagent blank. (auth)

26811 FLAME PHOTOMETRIC DETERMINATION OF ALKALI METALS, ALKALINE EARTHS AND COPPER IN NUCLEAR-GRADE URANIUM. **Podobnik, B.; Korosin, J.;**

Kosta, L. (Nuclear Inst. J. Stefan, Ljubljana, Yugoslavia). Z. Anal. Chem., 218: 184-92(1965).

A method, which involves prior chemical separation of uranium from impurities by tributylphosphate extraction, is described for the determination of alkali metals, alkaline earths, and copper in nuclear grade uranium. The characteristic emission lines, excited in a hydrogen-oxygen flame, are isolated by a small monochromator and recorded photoelectrically. Using 3 g samples, 0.005 ppM of Li, 0.001 ppM of Na, 0.05 ppM of K, 1 ppM of Mg, 1.5 ppM of Ba, and 2 ppM of Cu can be determined in uranium, with reproducibilities better than ±3%. Some interelemental interferences are discussed, and the possibilities of their elimination are described. The method can be used without modifications for analysis of uranium containing up to 100 ppM of impurities. (auth)

26812 A NEW HIGH-RESOLUTION MASS SPECTROGRAPH. Geerk, J. Z. Naturforsch., 21a: 34-6(Jan.-Feb. 1966). (In German).

The design and characteristics of a high-resolution mass spectrograph are described. The beam system and the image curve, together with the resolution error, are discussed. (J.S.R.)

26813 STUDY OF NEODYMIUM COMPLEXING WITH SELENOYLACETONE AND SELENOYLTRIFLUOROACETONE BY THE DISTRIBUTION METHOD. Peshkova, V. M.; Efimov, I. P.; Magdesieva, N. N. (Moscow State Univ.). Zh. Anal. Khim., 21: 499-501(1966). (In Russian).

Successive K_n and general β_n stability constants for neodymium selenoylacetonate ($lgK_1 = 5.62$, $lgK_2 = 5.42$, $lgK_3 = 4.48$) and neodymium selenoyltrifluoroacetonate ($lgK_1 = 5.04$, $lgK_2 = 4.78$, $lgK_3 = 3.87$) were determined by different methods. Conditions were studied for neodymium extraction with the above reagents from a chloroform–water medium. When neodymium is extracted with 0.1M solutions of selenoylacetone and selenoyltrifluoroacetone in chloroform the pH_{50} was found to be 7.20 and 3.50, respectively. (auth)

26814 RADIOACTIVATION METHOD FOR DETERMINING IMPURITIES IN ANTIMONY. Artyukhin, P. I.; Gilbert, E. N.; Pronin, V. A. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Zh. Anal. Khim., 21: 504-5(1966). (In Russian).

An activation method is suggested for determining microimpurities of Co, Cu, In, Zn, As, Te, and Sn in highly pure Sb. Sb is separated from the microimpurities by extraction with β,β'-dichlorodiethyl ether. Impurity elements are separated into two groups by means of Dowex-1 ion exchange resin in the F^--form. Then individual elements are separated by means of Dowex-1 ion exchange resin in the Cl^--form. Each impurity element is determined quantitatively by comparing its activity with that of the standard. (auth)

26815 EXTRACTION OF ZIRCONIUM WITH A BENZENE SOLUTION OF FATTY ACIDS. Kyrsh, M.; Selutski, P.; Pishtek, P. (Inst. for Nuclear Investigations, Prague). Zh. Neorg. Khim., 10: 2764-73(Dec. 1965). (In Russian).

For zirconium extraction a solution of fatty acids with a concentration of 1.0 moles/liter was added to a zirconium solution tagged with the ^{95}Zr isotope, in 0.1N HNO_3. Then, with agitation, a 2.5 molar solution of CH_3COONa in a 0.5 molar solution of NaOH was added to obtain the desired pH in the equilibrium aqueous phase (as a rule 5.9–6.0). After addition of the acetate, the solution was stirred for 30 min. The phase volume ratio was 1 and the re-extraction time was 30 min. After extraction, both phases were completely transparent. The autodiffusion coefficients were determined by diffusion from capillaries. Scattering of light by fatty acid solutions of zirconium was determined by a conventional method. A 10^{-3} molar solution of Zr(IV) in a 1.6% solution of fatty acids in benzene was ultracentrifuged for 4 hours at a rate of 59,800 rev/min and the optical diffraction was measured. Possible mechanism of the extraction are discussed. The data indicate that zirconium exists in the organic phase in the form of associated compounds of a colloidal nature. The co-extraction of trace quantities of yttrium, niobium, and other metals was observed during the extraction of zirconium with fatty acids. It was also found that zirconium, hafnium, and yttrium are efficiently sorbed by silica gel from the organic phase. It was established that the differences in the extraction of zirconium and hafnium in the system studied are not sufficient for separation of the two metals. (TCO)

Inorganic and Physical Chemistry

26816 (HW-72369) NON-METALLIC MATERIAL STUDIES FOR MOLTEN SALT PROCESSES. Kleinpeter, J. H. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Jan. 22, 1962. Contract AT(45-1)-1350. 12p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Alumina, aluminum silicate, silica, and zirconia which were tested in contact with molten sodium-potassium chloride were not significantly attacked. Only one sample of magnesia and one of 90% magnesia–10% titania were tested in the NaCl–KCl mixture of the Salt Cycle. Both were severely attacked. Calcium zirconate, yttria, and silicon nitride bonded silicon carbide were also attacked by the NaCl–KCl mixture. Silicon carbide and carbon were porous. Carbon would require an oxygen free atmosphere or lower operating temperature. Calcium fluoride proved to be much too sensitive to thermal shock to receive further consideration. Studies were made in large silica vessels. There were no instances noted of chemical attacks upon the vessel by the solution either during the dissolution or the electrolytic reduction steps. The principal trouble was from brittle failure upon heating or cooling. Most of the failures occurred during cooling or when attempting to remelt after the salt has frozen in a vessel. For the plutonium reduction cell, alumina and silica were found to contaminate the product, and for this reason, were not seriously considered. Calcium fluoride and yttria vessels were too sensitive to thermal shock; calcium zirconate, magnesium zirconate, and beryllia were unacceptably porous. Yttria stabilized zirconia, titanium diboride, and silicon nitride were attacked by the solution. The most promising material tested thus far for this service is the 10% titania–90% magnesia. (P.C.H.)

26817 (LA-3473) THE SCANDIUM–HYDROGEN SYSTEM. Stampfer, J. F. Jr. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Jan. 1966. Contract W-7405-eng-36. 28p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

A partial phase diagram for the scandium-hydrogen system was determined in the temperature range from 700 to 900°C and compositions ranging from $ScH_{0.4}$ to $ScH_{2.0}$. The equation that relates the hydrogen pressure over the supposed two solid phase region to the temperature was found to be $\log P_{torr} = -[(10.467 \pm 0.552)10^3/T] + 10.527 \pm 0.512)$. In this same region, the heat of formation of the hydrogen-rich phase from one mole of hydrogen and the hydrogen-poor phase was found to be −47.9 kcal/mole of H_2. Both the pressure equation and the heat of formation agree closely with other recently published data. In the plateau region, the higher temperature isotherms have a definite slope which should not be the case if there are only two components and two phases. Although there is a possibility that the presence of impurities may be the cause of the slope, the evidence is that this is not the case. No other explanation is offered. (auth)

26818 (LA-3481) THERMODYNAMICS OF INTERSTITIAL PHASES AND DEFECT COMPOUNDS. DePoorter, Gerald L. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Jan. 20, 1966. Contract W-7405-eng-36. 21p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Known thermodynamic properties were used to determine the validity of theoretical models for calculating thermodynamic properties of interstitial solid solutions and defect compounds. The model for interstitial solid solutions is shown to be unacceptable for several reasons, and the model for defect compounds does not satisfy the assumptions on which it is based. (auth)

26819 (NML-64-2) HIGH FIELD MOESSBAUER STUDY OF LOCALIZED MAGNETIC MOMENTS IN METALS. Blum, Norman Allen (National Magnet Lab., Massachusetts Inst. of Tech., Cambridge). Nov. 1964. Contract AF 19(604)-7344. 184p.

The Mössbauer effect in ^{57}Fe was used as a tool to study the magnetic behavior of a dilute concentration of iron atoms in various nonmagnetic metal hosts. Experiments were performed in external magnetic fields up to 143 kOe and at temperatures from 1.2 to 320°K. It is found that 1% Fe in Mo, Rh, $Pd_{0.8}Rh_{0.2}$, and ^{57}Fe resulting from the radioactive decay of small concentrations of ^{57}Co in Cu and Au show a localized magnetic moment on the solute atoms. In these hosts the hyperfine field at the ^{57}Fe nucleus H_n, consists of the applied field H_0, plus an induced field H_{in}, which is proportional to a Brillouin function describing the alignment of a free paramagnetic moment in an applied magnetic field: $H_{in} = -H_{sat}Bj(H_0/T)$. The values of H_{sat} are interpreted as being proportional to the moment on the iron atom μ_{Fe}, and J as the total angular momentum of the cluster, consisting of the solute atom plus the coupled neighboring solvent atoms, which behaves paramagnetically with a magnetic moment $\mu = gJ\mu_B$. These results are shown to be consistent with the magnetic susceptibility experiments and explain the existence of the very large moments observed in the Pd and PdRh alloy hosts. A sample of ½% Fe in Cr exhibits a spontaneous hyperfine field H_{int}, below 50°K of +35 kOe. The hyperfine field H_n, below 50°K is independent of T and cannot be explained simply in terms of a localized magnetic moment on the solute atom. Alloys of 1% Fe in Ti and Sc show that $H_n = H_0$ for all fields and temperatures studied. The observed absence of a localized moment in the Ti alloy is associated with the anomalous increase in the superconducting transition temperature of Ti by the addition of small quantities of iron. Background information concerning the origin of the hyperfine field and the existence of localized magnetic moments is given together with an interpretation of the Mössbauer experiments and their relation to the results of magnetic susceptibility experiments. The velocity spectrometer, used to obtain the experimental data, is described in detail. A technique for ascertaining the sign of the hyperfine field is described and several examples of its application are given. (auth)

26820 (SC-CR-66-2019) DETERMINATION OF PHYSICAL-CHEMICAL CHARACTERISTICS OF METAL–METAL OXIDE MIXTURES. Final Report, April 6–July 5, 1965. Austing, James L.; Kennedy, James E. (IIT Research Inst., Chicago, Ill.). Jan. 26, 1966. Contract AT(29-1)-789. 205p. Dep. mn. CFSTI $6.00 cy, $1.25 mn.

For Sandia Corp., Albuquerque, N. Mex.

A combined experimental and theoretical study on the ignition of metal-metal oxide mixtures in contact with electrically pulsed bridgewires was performed. The systems that were studied included aluminum–tungstic oxide, aluminum–copper oxide, aluminum–vanadium pentoxide, and aluminum–molybdic oxide. The thermal conductivity of metal-metal oxide pellets pressed at 5000 psi in air was measured, and values of approximately 1×10^{-3} cal/sec cm²°C were obtained. Variation in the percentage of aluminum in the mixture had an observable effect on thermal conductivity. Constant current ignition tests were conducted over a range of 7 to 50 amperes, using a low-inductance firing circuit that had a rise time of 10 μsec. The metal-metal oxide powder was pressed into initiators containing Kovar-glass headers bridged with 5-mil Evanohm wire. Resistance during firing and overall function time of the initiator were monitored. The time of ignition of the metal-metal oxide was clearly evident on the records. Excellent correlation of burning rate with density was obtained for the Al–WO_3 systems. For most systems, an increase in density caused slower burning of the column. An increase in aluminum content caused more rapid burning. The manner in which the bridgewire was welded to the prongs of the Kovar-glass header was studied. Headers on which the bridgewire was welded in a cross-eyed manner caused a noticeable decrease in ignition time variation, as compared to that for headers in which the bridgewire weld position was not controlled. The heat loss factor of the Rosenthal electro-thermal equation was determined for initiators loaded with pressed metal-metal oxide. Values of heat loss factor were in the range 0.0050 to 0.0270 watts/°C, but did not correlate with metal-metal oxide density. Comparison of the experimentally observed ignition times with calculated bridgewire temperature histories for selected heat loss factor values showed that ignition occurred sometime after bridgewire melting. (P.C.H.)

26821 (SRIA-106-38) [CHEMISTRY OF MOLTEN SALTS AND METAL-SALT SOLUTIONS AT ELEVATED TEMPERATURES]. Ten-Year Summary of Accomplishments. Technical Report No. XLIII. Cubicciotti, Daniel (Stanford Research Inst., Menlo Park, Calif.). Apr. 6, 1966. Contract AT(04-3)-106. 24p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Research is summarized on metal-salt phase diagrams, activities in metal-salt solutions, metal-salt volumes of mixing, and electrolysis of Bi–$BiCl_3$ mixtures. Information is included concerning the chemistry of divalent halides and thallous halides. Research progress is also summarized on molten-salt enthalpies and entropies, and vaporization of salts at pressures below one atmosphere. Brief summaries are included on energies of alkaline earth halides, transpiration of $ZnCl_2$, enthalpy of thallous fluoride, and methods for vapor pressure data analysis. (J.R.D.)

26822 (TID-22966) DIFFUSION IN ZEOLITES AND GLASSES. Technical Progress Report. Brandt, Werner W. (Wisconsin Univ., Madison. Dept. of Chemistry). Mar. 1966. Contract AT(11-1)-1550. 15p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

X-ray diffraction measurements were made on several lithia borates and lead borates. Preliminary results showed a strong tendency to crystallization in both composition series only near 0 and 100 mole % lithia, or lead oxide content. Also, preliminary results on etching to determine if phase separations occur in the glasses of interest were negative. However studies along this line will be continued. (P.C.H.)

26823 REACTION OF CHLORINE AND URANIUM TETRACHLORIDE IN THE FUSED LITHIUM CHLORIDE–POTASSIUM CHLORIDE EUTECTIC. Olander, Donald R.; Camahort, J. L. (Univ. of California, Berkeley). A.I.Ch.E. (Amer. Inst. Chem. Eng.) J., 12: 693-9(July 1966). (UCRL-16249; UCRL-16249(Rev.)).

The rates of the reaction of chlorine gas with uranium tetrachloride dissolved in the lithium chloride–potassium chloride eutectic were studied in a wetted-rod contactor. The reaction was studied at temperatures from 400 to 700°C, uranium tetrachloride concentrations of 1 to 3 wt %, and chlorine partial pressures of 0.25 to 1 atm. The production of uranium hexachloride appeared to be limited by the equilibrium of the reaction UCl_4 (solution) + $Cl_2(g) \rightarrow UCl_6$ (solution) at the interface and by U^{4+} diffusion in the liquid phase. (auth)

26824 NMR STUDY OF THE ROH–D_2O SYSTEMS. II. BUTANOL-1, BUTANOL-2, METHYL-PROPANOL-1, METHYL-PROPANOL-2. Cernicki, B. (Research Inst. of the Organsko kemijska industrija, Zagreb). Ber. Bunsenges. Physik. Chem., 70: 154-6(Mar. 1966). (In German).

The NMR spectra of mixtures of butanol-1, butanol-2, methyl-propanol-1, and methyl-propanol-2 with heavy water are discussed. The intensities of the hydroxyl and water signals were found to agree with the theoretical probability curves. No coalescence of these signals could be found in the miscibility region. The influence of the dilution effect and of the magnetic field strength on the spectra is mentioned. (auth)

26825 PROTON MAGNETIC RESONANCE STUDIES ON HYDROGEN DIFFUSION IN THE TANTALUM–HYDROGEN SYSTEM. COMMENTS ON STRUCTURE OF β-TANTALUM HYDRIDE. Stalinski, B.; Zogal, O. J. (Institute of Structural Research, Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Chim., 14: 143-7(1966).

A study was made of the structure and mobility of hydrogen atoms in the crystal lattice of tantalum hydride by steady-state NMR methods. All samples investigated showed diffusional narrowing of the resonance lines with increasing temperature. In the low-temperature range the shape of the resonance lines was nearly Gaussian. The activation energies estimated for samples with the highest hydrogen concentrations were close to 2.5 kcal. A marked diminution of the activation energy with decreasing hydrogen content was observed. (F.J.H.)

26826 ENTHALPY OF FORMATION OF NICKEL HYDRIDE AND DEUTERIDE. Czarnota, I.; Baranowski, B. (Inst. of Physical Chemistry, Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Chim., 14: 191-6(1966).

Determination of enthalpies of formation and phase characters of nickel deuterides and hydrides is discussed. The preparation procedures, calorimetric measurements, and calculations are described. The heats of formation (cal/mole D_2 and H_2) of nickel deuteride and hydride, respectively, are presented as a function of D:Ni and H:Ni atomic ratios. The results showed a close similarity between the H–Ni and H–Pd systems. (F.J.H.)

26827 SOME PROTACTINIUM(IV) HALIDES, THEIR COMPLEXES, AND HEXAHALOGENO-SALTS. Brown, D.; Jones, P. J. (Atomic Energy Research Establishment, Harwell, Eng.). Chem. Commun., No. 9, 279-80(May 11, 1966).

The preparation and some properties of the tetrabromide, tetraethylammonium hexachloro- and hexabromo-protactinates(IV) and some complexes formed by $PaCl_4$ and $PaBa_4$ with oxygen and nitrogen donor ligands are described. X-ray powder diffraction studies indicated that the tetrabromide is isostructural with thorium tetrabromide possessing tetragonal symmetry with $a_0 = 8.824$, $c_0 = 7.957 \pm 0.002$ Å. The hexabromoprotactinate(IV) is isostructural with the corresponding thorium(IV) and uranium(IV) salts. Because of the rapid oxidation of protactinium(IV) in the atmosphere all compound were prepared in an argon-filled box. (F.J.H.)

26828 REDUCTION OF EUROPIUM SESQUIOXIDE BY HYDROGEN. PREPARATION OF THE OXIDE Eu_3O_4 AND SOME EUROPIUM ALUMINATES. Achard, Jean-Claude; Albert, Louis (CNRS, Bellevue, France). Compt. Rend. Ser. C, 262: 1066-9(Mar. 28, 1966). (In French).

Europium sesquioxide was reduced by hydrogen. The reduction began at 1300°C. Between 1300 and 1600°C reduction was accomplished without volatilization of the reaction products. The total degree of oxidation of the products varied between $EuO_{1.5}$ and $EuO_{1.34}$. It approached $EuO_{1.33}$ as the temperature and the reaction time were increased. The x-ray diffraction spectrum indicated a mixture of two phases. Above 1600° Eu_3O_4 was volatilized. The aluminates $EuO \cdot Al_2O_3$ and $EuO \cdot 6Al_2O_3$ were prepared by heating stoichiometric mixtures of Eu_2O_3 and Al_2O_3 to 1500 and 2000°C, respectively. The x-ray diffraction data on the two compounds are tabulated. (J.S.R.)

26829 SULFIDE COMPOUNDS OF RARE EARTHS AND SILVER OF THE TYPE Th_3P_4. Ballestracci, Regis (Centre d'Etudes Nucleaires, Grenoble, France). Compt. Rend., Ser. C, 262: 1155-6(Apr. 4, 1966). (In French).

The structure of rare earth silver sulfides AgT_5S_8 was deduced from the structure (type Th_3P_4) of the γ lacunar sulfides T_2S_3 by statistically replacing 0.33 T^{3+} + 0.66 □ by an Ag^+ ion. The region of existence of this phase extends from La to Dy. (tr-auth)

26830 STUDIES ON β-DIKETONATES OF SCANDIUM AND YTTRIUM. Purushottam, D.; Raghava Rao, Bh. S. V. (Andhra Univ., Waltair, India). Indian J. Chem., 4: 109-10 (Mar. 1966).

Chelates of scandium and yttrium with benzoylacetone, dibenzoylmethane, and 2-thenoyltrifluoroacetone as ligands were prepared by dissolving the oxide of the metal in nitric acid, evaporating the acid, and taking up the residual nitrate in absolute ethanol. A solution of the pure ligand in absolute ethanol is then added to this solution and the pH of the mixture adjusted to 6.2 or 6.4 (depending upon the metal employed) by the addition of ammoniacal ethanol. Some of the physical properties of the chelates and their ultraviolet absorption spectral data in methanol, ethanol, n-hexane, and cyclohexane were recorded. The metal ions and the ligands did not have any characteristic absorption in the visible region. (auth)

26831 THORIUM β-DIKETONATES. Purushottam, D.; Raghava Rao, Bh. S. V. (Andhra Univ., Waltair, India). Indian J. Chem., 4: 142-3(Mar. 1966).

Chelates of thorium with β-diketones, viz. benzoylacetone, dibenzoylmethane, and thenoyltrifluoroacetone were prepared and characterized, and their uv absorption spectra recorded in four different solvents. A metal to ligand ratio of 1:4 was found in all the chelates which generally show 2 absorption maxima in HV region in all the solvents. (auth)

26832 CRYSTAL STRUCTURE OF THE RHOMBOHEDRAL $MO_3 \cdot 3R_2O_3$ COMPOUNDS (M = U, W, OR Mo) AND THEIR RELATION TO ORDERED R_7O_{12} PHASES. Bartram, S. F. (General Electric Co., Cincinnati). Contract AT(40-1)-2847. Inorg. Chem., 5: 749-54(May 1966).

A complete three-dimensional structure analysis of the complex oxide $UO_3 \cdot 3Y_2O_3$ was carried out using single-crystal data. This structure is characteristic of a large family of rhombohedral compounds containing rare earth oxides and having an oxygen-to-metal ratio of 12:7. Bond lengths and coordination polyhedra for the atoms in this rhombohedral structure were compared with those in other known oxides. The relation between $U_mY_{7-m}O_{12}$ compositions ($1 < m < 2.0$) and ordered $RO_{1.71}$ phases is shown. Some conclusions are drawn as to their mode of oxidation. (auth)

26833 PHASE RELATIONSHIPS IN THE RARE EARTH SESQUIOXIDES AT HIGH PRESSURE. Hoekstra, Henry R. (Argonne National Lab., Ill.). Inorg. Chem., 5: 754-7 (May 1966).

Phase relationships in the rare earth sesquioxides were studied at pressures from 15 to 60 kbars at 550, 1000, and 1450°C. No measurable shift was observed in the boundary between the hexagonal (A) and monoclinic (B) phases, but stability of the monoclinic phase relative to the cubic phase was enhanced by increased pressure as well as higher temperature. The C–B phase transformations are shown to be reversible. Lattice parameters are given for 11 monoclinic sesquioxides — Y_2O_3 and Sm_2O_3 through Lu_2O_3. The entropy increase involved in the transformation from the cubic to monoclinic structure is estimated to be 1.5 eu. (auth)

26834 RARE EARTH METAL–METAL HALIDE SYSTEMS. X. PHASE STUDIES OF THE YTTRIUM AND ERBIUM CHLORIDES AND IODIDES. A CORRELATION OF THE REDUCTION CHARACTERISTICS OF THE RARE EARTH ELEMENTS. Corbett, John D.; Pollard, Daniel L.; Mee, Jack E. (Ames Lab., Ames, Iowa). Inorg. Chem., 5: 761-6(May 1966). (IS–1284).

Yttrium and erbium react with their respective molten chlorides and iodides without the formation of intermediate phases. The eutectic temperatures and compositions (mole % M) are: YCl_3, 715–716°, 2.3%; YI_3, 948°, 11.8%; $ErCl_3$, 746°, 4.8%; ErI_3, 933°, 11.0%. The cryoscopic analysis of the $ErCl_3$ solution data and the apparently large ΔS°_{fus} for other halides with the BiI_3-type structure are discussed. The magnitudes of the reaction of the scandium family and lanthanide metals with their respective molten trichlorides exhibit considerable irregularity in the heavy lanthanides, where Yb > Dy (~Tm?) > Ho > Er > Gd, and also in the scandium group, Sc > La > Y. The extent of the presumed reduction of $MCl_3(l)$ to $MCl_2(l)$ at 800° for lanthanum through ytterbium was found to correlate very well with $\Delta F^{\circ}_f + I_1 + I_2$ for the metal. Changes in the sublimation energies appear primarily responsible for the observed trends, with only relatively small effects arising from minor changes in the first two ionization steps and, evidently, in other terms in the complete Born-Haber cycle as well. Predictions of limiting compositions in unknown MCl_3–M systems are made on this basis for Tb (7 mole %), Lu (≤1%), and Tm (32%). No clear explanation is evi-

dent for the small reduction of yttrium(III) relative to that of lanthanum and scandium. The nature of the lanthanide elements themselves which appears so important in the relative stabilities of the dichlorides as well as other treatments and predictions of stability is also considered. (auth)

26835 OBSERVATION OF ASTATINE COMPOUNDS BY TIME-OF-FLIGHT MASS SPECTROMETRY. Appelman, E. H.; Sloth, E. N.; Studier, M. H. (Argonne National Lab., Ill.). Inorg. Chem., 5: 766-9(May 1966).

Astatine compounds were prepared and then identified in a time-of-flight mass spectrometer. The compounds observed were HAt, CH_3At, AtI, AtBr, and AtCl. No evidence was found for the existence of At_2. An attempt to identify astatine fluorides was unsuccessful. (auth)

26836 KINETICS OF THE LIGAND EXCHANGE BETWEEN ZIRCONIUM, HAFNIUM, AND THORIUM CHELATES AND FREE β-DIKETONES MEASURED BY NUCLEAR MAGNETIC RESONANCE. Adams, A. C.; Larsen, Edwin M. (Univ. of Wisconsin, Madison). Inorg. Chem., 5: 814-19(May 1966).

The exchange reactions of zirconium and hafnium trifluoroacetylacetonates with the free ligand in benzene and chlorobenzene and of the metal acetylacetonates with the free ligand in chlorobenzene are first order in both metal complex and free ligand. The acetylacetone exchange in benzene has a different rate law. The order with respect to the metal complex is one; however, the order with respect to the free ligand increases as the acetylacetone concentration increases. Rates for acetylacetone exchange in benzene and chlorobenzene are faster for zirconium than for hafnium; however, for the trifluoroacetylacetone ligands, the exchange rates are essentially the same for both metals. The exchange for thorium is faster than for zirconium or hafnium. The activation parameters are similar for all of the systems studied except for the exchange of acetylacetone in benzene. A mechanism for the ligand exchange is proposed. (auth)

26837 SUCCESSIVE STABILITIES AND PROPOSED MODELS OF THE RARE EARTH 1-HYDROXYCYCLOPENTANECARBOXYLIC ACID CHELATES. Powell, J. E.; Rowlands, D. L. G. (Ames Lab., Ames, Iowa). Inorg. Chem., 5: 819-22(May 1966). (IS-1288).

The formation constants of the first three chelate species of the tripositive rare earth cations with the 1-hydroxycyclopentane-carboxylic acid ligand (HCPC) were determined. Some values of K_4 were determined where calculable. Measurement was by a potentiometric method at 25°C, and the ionic medium was maintained at $\mu = 0.1$ by the supporting electrolyte, sodium perchlorate. The ionization constant of the acid was also determined over the same ligand concentration range. From the stability constant ratios and hydration data of solid species, obtained using a thermobalance technique, an effort was made to postulate the coordination number in the complex and the dentate character of the ligand, based on the nine-coordinate, trigonal prism +3 model. (auth)

26838 METHANOL EXCHANGE IN DILUTE SOLUTIONS OF NEPTUNIUM(V) IONS BY NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY. Sheppard, John C.; Burdett, Jane L. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1350. Inorg. Chem., 5: 921-5(May 1966).

The relaxation of the methyl and hydroxyl protons of methanol by neptunium(V) was examined over the temperature range of −80 to +50°C. The results indicated that the rate of methanol exchange between the coordination sphere of neptunium(V) and the bulk solvent is measurable and has a rate constant of 9.0×10^4 sec^{-1} at 0°. ΔH^* and ΔS^* for this reaction are 7.5 kcal/mole and −8 eu, respectively. (auth)

26839 OXIDATION OF URANIUM(IV) ACETATE BY SILVER ACETATE IN LIQUID AMMONIA. Kline, Robert J.; Kershner, Carl J. (Ohio Univ., Athens). Contract AT(11-1)-362. Inorg. Chem., 5: 932-4(May 1966).

The oxidation of uranium(IV) acetate in liquid ammonia by silver acetate was studied. The reaction was followed by the slow precipitation of a pale yellow substance as the solution color faded. Results indicated that uranium(VI) production was nearly quantitative. The acetamide produced per mole of uranium(VI) increased with time. Since the oxidation reaction is much faster than the ammonolysis reaction, it was concluded that the acetamide produced in the oxidation reaction results from acetate involved in oxygen atom transfer to form the dioxouranium(VI) species. Following this, additional acetamide was formed by the ammonolysis of acetate attached to U(VI). (J.G.B.)

26840 RARE EARTH METAL–METAL HALIDE SYSTEMS. IX. THE DYSPROSIUM–DYSPROSIUM(III) CHLORIDE SYSTEM AND THE PREPARATION OF DYSPROSIUM(II) CHLORIDE. Corbett, John D.; McCollum, Bill C. (Ames Lab., Ames, Iowa). Inorg. Chem., 5: 938-40(May 1966). (IS-1285).

Phase studies were made on the dysprosium–dysprosium(III) chloride system. The metal solubility was found to be quite substantial, 15 mole % at the 507° eutectic and 31.0 mole % at 800°C. There were two intermediate phases present — $DyCl_{2.1}$ (29.6% Dy), decomposing at 675°C into $DyCl_2$ and liquid of composition about $DyCl_{2.15}$, and $DyCl_2$, which at 721°C is in equilibrium with Dy and a liquid about $DyCl_{2.08}$. The two stable lower chloride phases are black, electrically insulating, and highly susceptible to attack by air. Results of x-ray powder pattern studies are discussed. (J.G.B.)

26841 EVALUATION OF ISOTOPE SEPARATION FACTOR FOR 1-^{14}C LYSINE ON EXCHANGE RESINS WITH CARBOXYLIC GROUPS. Bellobono, I. R.; Gaiazzi, G. (RHO, Milan). Int. J. Appl. Radiat. Isotop., 17: 257-60(May 1966).

The equilibrium constant (elementary separation factor) for the isotopic exchange reaction of l-^{14}C D-L-lysine on resins with carboxylic groups was determined at 25°C, by means of breakthrough curves and suitable correlation of data obtained by simultaneous spectrophotometric and radiometric analysis. From overall isotope effects and the height equivalent of a theoretical plate for the chromatographic column employed, the elementary separation factor could be calculated. (auth)

26842 ^{13}C NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY. I. ^{13}C CHEMICAL SHIFT CHART AND THE SPECTROMETER. CHEMICAL SHIFTS OF NITRILES, HETEROCYCLIC COMPOUNDS, CYCLOPROPYL KETONES AND SOME VINYL COMPOUNDS. Lippmaa, E.; Olivson, A.; Past, J. (Inst. of Cybernetics, Academy of Sciences, Estonian SSR). Izv. Akad. Nauk Est. SSR, Ser. Fiz. Mat. Tekh. Nauk, No. 3, 473-86(1965). (In Russian).

^{13}C chemical shifts can be used for direct investigation of the carbon skeleton of molecules, for isotopic tracer studies, and in order to assess the practical value and applicability of various concepts and theories of quantum chemistry as well as for various other studies (steric inhibition of conjugation, effects of magnetic anisotropy, correlations with Hammett and Taft constants, etc). To facilitate these investigations a concise ^{13}C chemical shift chart was compiled including all data published prior to 1965 and some data derived from the present work. Some groups of compounds not covered previously (nitriles, 5-membered heterocycles, cyclopropyl ketones, vinyl compounds with polar substituents) were investigated. A universal spectrometer, using frequency synthesis and spin stabilization whenever necessary, was built for the frequency range from 1.45 to 25.75 Mc. The base-line drift was practically eliminated by the use of high-frequency (4 kc) magnetic field modulation. (auth)

26843 SYNTHESIS OF RARE EARTH ELEMENT CHALCOGENIDES. Golubkov, A. V.; Zhukova, T. B.; Sergeeva, V. M. (Inst. of Semiconductors, USSR). Izv. Akad. Nauk SSSR, Neorg. Mater., 2: 77-81(Jan. 1966). (In Russian).

A method of direct synthesis was developed for higher purity poly and single crystalline rare earth metal monochalcogenides, MX, and sesquichalcogenides, M_2X_3, where

M = La, Pr, Nd, and Ce and X = S, Se, and Te. Nonstoichiometric and low purity compounds were obtained in the earlier used methods, mainly because of oxidation or contamination with the impurities from the container. A two-step process excludes these causes of contamination. The first step of the process consists of reacting rare earth metal shavings with chalcogen vapors below 600°C in evacuated and hydrogen filled ampuls of thermally stable glass. In the second step, the reaction product is either annealed by resistance heating at 1600 to 1800°C in high vacuum to prepare macrocrystalline MX, or annealed and melted by induction heating at 1500 to 2000°C also in high vacuum to grow, by sublimation, well-developed MX single crystals. Water cooling of the container is required in the latter variant to prevent oxidation of MX. Preparation of polycrystalline M_2X_3 ingots also requires high-temperature annealing and melting in an induction furnace, but in an argon atmosphere and without cooling of the ampul. Lattice constants a of the polycrystalline MX were in good agreement with literature data. In the case of LaS, PrSe, and PrTe single crystals the a values were determined with greater accuracy and were in good agreement with the a values of polycrystalline compounds. Electric conductivity data at 300°K for MX were much higher than literature data because of the higher purity of the products. Electric resistivity of M_2X_3 in the 10^4 to 10^5 ohm · cm range indicated a nearly stoichiometric composition. (ATD)

26844 PREPARATION AND SOME PHYSICOCHEMICAL PROPERTIES OF RARE EARTH OXYTELLURIDES. Obolonchik, V. A.; Lashkarev, G. V.; Dem'yanchuk, V. G. (Inst. of Materials Science Problems, Academy of Sciences, SSSR). Izv. Akad. Nauk SSSR, Neorg. Mater., 2: 100-4(Jan. 1966). (In Russian).

Oxytellurides of stoichiometric composition corresponding to the formula M_2O_2Te (where M = La, Ce, Pr, Nd, Sm, Gd, and Dy) were synthesized by reacting rare earth oxides with tellurium vapor in a hydrogen atmosphere in graphite boats at temperatures from 1000 to 1100°C. The oxytellurides are unstable. Lanthanum, praseodymium, neodymium, and samarium oxytellurides are stable at elevated temperatures in air because of formation of a thin metal oxide film on the surface. The electric conductivity at room temperature and the temperature dependence of the thermal expansion of praseodymium, neodymium, and samarium oxytellurides were measured, as was the temperature dependence of the magnetic susceptibility of the oxytellurides from lanthanum to samarium. The nature of chemical bonding, which causes the conductivity of these compounds to be nonmetallic in character, is discussed. (ATD)

26845 EFFECT OF GASEOUS MEDIA ON THE INTERACTION BETWEEN ZIRCONIUM DIOXIDE AND CERIUM OXIDES. Leonov, A. I.; Andreeva, A. B.; Keler, E. K. (Inst. of Silicate Chemistry, Academy of Sciences, SSSR). Izv. Akad. Nauk SSSR, Neorg. Mater., 2: 137-44 (Jan. 1966). (In Russian).

The phase relations in the $ZrO_2-Ce_2O_3$ system were studied in a reducing atmosphere. Formation of the pyrochlore-type compound $Ce_2Zr_2O_7$ and three solid solutions based on zirconium dioxide, a monoclinic (below 1000°C), tetragonal (above 1000°C), and cubic solid solution (from 5 to 17 mole % Ce_2O_3), stable at high temperatures, were established. A metastable solid solution based on Ce_2O_3 and a region of immiscibility between the indicated phases were also found. Dilatometric measurements established that in the concentration range from 0 to 27 mole % Ce_2O_3 there is a reversible polymorphic transformation of zirconium dioxide with hysteresis at 900 to 1200°C. At a Ce_2O_3 content in excess of 27 mole %, the polymorphism of ZrO_2 is completely suppressed. The effect of partial pressure of oxygen on the valence changes $Ce^{4+} \rightleftharpoons Ce^{3+}$ and on physicochemical properties of ZrO_2 was studied in the $ZrO_2-CeO_2(Ce_2O_3)$ system. Cerium, which is in the form of CeO_2 in the solid solution in ZrO_2, converts to the trivalent state at high temperatures in a reducing atmosphere (H_2, CO, and NH_3), in a vacuum (10^{-3} to 10^{-4} mm Hg), in an inert gas stream (Ar and He), and in the atmosphere of reverberatory furnaces with a low partial pressure of oxygen ($p_{O_2} = 1.4 \times 10^{-5}$ atm at 1400°C). Alternate oxidation and reduction of cerium-containing zirconium refractories causes loosening and cracking of the material as a result of volume changes associated with the oxidation-reduction processes. (ATD)

26846 REACTIONS OF NEODYMIUM AND CERIUM OXIDES WITH SODIUM BORATE MELTS. Tananaev, I. V.; Belyakov, I. M. Dzhurinskii, B. F.; Berul', S. I. (Kurnakov Inst. of General and Inorganic Chemistry, Academy of Sciences, SSSR). Izv. Akad. Nauk SSSR, Neorg. Mater., 2: 165-8(Jan. 1966). (In Russian).

Reactions in the liquid phase were studied in the $Na_2O-B_2O_3-Nd_2O_3$ and $Na_2O-B_2O_3-CeO_2$ systems under isothermal and polythermal conditions to obtain data on solubility of the rare earths in sodium borate melts and crystallization of the rare earth borates. These data are required for growing single crystals of rare earth borates and for preparing glasses activated with rare earth ions. Solubilities of Nd_2O_3 and CeO_2 were determined at 900 and 1000°C in the melts containing B_2O_3 and Na_2O in a ratio of from 2 : 1 to 17 : 1. This region of compositions was selected as practically the most important from the viewpoint of glass formation. It was noted that the behavior of Nd_2O_3 and CeO_2 in these melts differed. The solubility of Nd_2O_3 was significantly higher than that of CeO_2 because of the formation of neodymium borates, $NdBO_3$ and $Nd(BO_2)_3$, which crystallized in the 2 to 3.72 and 3.72 to 17 B_2O_3/Na_2O range, respectively. CeO_2 apparently did not form any compound and its solubility was only slightly dependent on the composition of melts. The great solubility of Nd_2O_3 in the $Na_2O-B_2O_3$ melts made it possible to grow $NdBO_3$ single crystals up to several millimeters in size. Such crystals were grown by slow cooling of the borax melt saturated with Nd_2O_3 at 1000°C. Liquidus curves of the $Na_2B_4O_7-Nd_2O_3$ section and $Na_2B_4O_7-CeO_2$ section of the phase diagrams were established for both systems studied. The liquidus branch of the $Na_2B_4O_7-Nd_2O_3$ system in the 690 to 1000°C range, and the branch of the $Na_2B_4O_7-CeO_2$ system in the 740 to 1100°C range corresponded to $NdBO_3$ and CeO_2 crystallization, both without any polymorphic conversion. Transition points on the liquidus curves at 910°C for $Na_2B_4O_7-Nd_2O_3$ and 930°C for $Na_2B_4O_7-CeO_2$ systems were attributed to some structural changes in the polymeric $Na_2B_4O_7$ melt. (ATD)

26847 ADSORPTION OF CERIUM(III) ON ACTIVATED MANGANESE DIOXIDE. Belousov, E. A.; Kolobov, N. P. Izv. Vyssh. Ucheb. Zaved., Khim. Khim. Tekhnol., 8: 1026-7(1966). (In Russian).

The temperature dependence of the degrees of adsorption of different concentrations of cerium(III) on activated manganese dioxide was investigated. The dependence of the degree of absorption on the acid solution at 80°C is shown. The results led to the conclusion that the degree of adsorption increases as the temperature increases and as the sulfuric acid concentration and the concentration of Ce in the solution decrease. (tr-auth)

26848 ISOMORPHOUS COMPLEX FLUORIDES OF TRI-, TETRA-, AND PENTAVALENT URANIUM. Thoma, R. E. (Oak Ridge National Lab., Tenn.); Friedman, H. A.; Penneman, R. A. J. Amer. Chem. Soc., 88: 2046-7(May 5, 1966).

Preparation of complex fluorides formed between UF_3 and alkali fluorides (CsF, KF, and RbF) is reported. Investigations demonstrated that the reaction of UF_3 with alkali fluorides yields complex compounds of U(III). Those found had MF : UF_3 ratios of 1 : 1 for M = Cs^+, K^+, Rb^+, or Na^+; 2 : 1 (except for Na^+); and 3 : 1 (except for Na^+). No complex compounds of UF_3 were formed with LiF. Results obtained with $3KF \cdot UF_3$, $3KF \cdot UF_4$, and $3KF \cdot UF_5$ are given. (F.J.H.)

26849 FORMATION OF HOT OH BONDS IN THE RADIATIONLESS RELAXATIONS OF EXCITED RARE EARTH IONS IN AQUEOUS SOLUTIONS. Heller, Adam (General Telephone and Electronics Labs., Bayside, N. Y.). J. Amer. Chem. Soc., 88: 2058-9(May 5, 1966).

Evidence that at least in aqueous solutions of some rare earth ions the electronic energy of the excited rare earth

ion is transferred to a single vibrational mode excited to a high vibrational state is presented. The rare earth ion–D_2O–H_2O system offers several advantages in radiationless deexcitation studies. The relation between I_0/I and [H] is linear for 0.1M rare earth chloride solutions at 23.5 ± 3°C over the 0 to 10% H_2O concentration range, in agreement with previous results. Using a value of 3600 cm^{-1} for the fundamental OH vibration, it was found that the changes in the vibrational quantum numbers that are required to bridge the smallest gaps between the excited and ground multiplets are $\Delta\nu \geq 5$ for terbium, $\Delta\nu \geq 4$ for europium, $\Delta\nu \geq 2$ for samarium, and $\Delta\nu \geq 2$ for dysprosium. These results indicated that vibrational transitions in the energy acceptor are not necessarily subject to optical selection rules; energy may be transferred to a single bond that is excited to a high vibrational state. (F.J.H.)

26850 PREPARATION AND PROPERTIES OF MONOCESIUM XENATE ($CsHXeO_4$). Jaselskis, Bruno; Spittler, T. M.; Huston, J. L. (Loyola Univ., Chicago). J. Amer. Chem. Soc., 88: 2149-50(May 20, 1966).

Crystalline monocesium xenate was prepared by the reaction of xenon trioxide with aqueous cesium hydroxide in the presence of fluoride ions. Good yields of cesium xenate were obtained from solutions approximately 0.1M in xenon trioxide, 0.1M in fluoride ion, and 2.5M in cesium hydroxide. Cesium xenate, which has an apparent formula weight of 334, is stable in air and is considerably more stable than xenon trioxide. The existence of monocesium xenate was confirmed by the determination of the oxidation equivalent by the "hi-lo" titration method, x-ray powder diffraction patterns, and infrared spectroscopy. (auth)

26851 HYDROGEN-DEUTERIUM EQUILIBRATION AND PARAHYDROGEN AND ORTHODEUTERIUM CONVERSION OVER PALLADIUM: KINETICS AND MECHANISM. Scholten, J. J. F.; Konvalinka, J. A. (Staatsmijnen in Limburg, Geleen, Netherlands). J. Catalysis, 5: 1-17(Feb. 1966).

In an attempt to clarify the mechanism of reaction of hydrogen at the surface of metals, an extensive study was made of the kinetics and mechanisms of the hydrogen-deuterium equilibration and the parahydrogen and ortho-deuterium conversion over palladium wire and sponge. The occurrence of two palladium-hydrogen phases at the surface influences the kinetic behavior. The kinetics over samples are described by the general equation: $v = Ap^{\sim 0.63} \exp(-12{,}500/RT)$, where v is the reaction rate, A is a constant, and p is the pressure in mm of mercury. Primary and secondary isotope effects are discussed, and a reaction mechanism is proposed which is closely related to the Rideal mechanism and which accounts for the marked pressure dependence of the reaction. The formulation presented points to the occurrence of a thermodynamic isotope effect besides a kinetic isotope effect. This means that an apparent activation energy is involved. (TCO)

26852 STUDY OF THE ISOTOPIC EXCHANGE REACTION OF IODINE RADIO-GAS CHROMATOGRAPHY. Machiroux, R. (Univ., Liege). J. Chromatog., 22: 234-44(May 1966). (In French).

The exchange reaction of iodine between CH_3I and C_2H_5I was studied at 92.4°C in p-dioxane, ethyl alcohol, methyl alcohol, n- and isopropyl alcohol and acetonitrile. It appeared that the reaction proceeds by an ionic mechanism of the second order and that the rate constant is: $k = (0.87 \pm 0.09) \cdot 10^{-3}$ ($l \cdot m^{-1} \cdot sec^{-1}$). The effect of the dielectric constant of the solvent confirmed the ionic character of the reaction. The principal reaction that takes place in the hydroxylated solvents is accompanied by a secondary process: $RI + R'OH \rightarrow R-O-R' + HI$ ($R \equiv CH_3$-, C_2H_5-) ($R' \equiv CH_3$-, C_2H_5- n- and iso-C_3H_7-). This secondary reaction, giving rise to exchangeable hydriodic acid, did not seem to affect the course of the principal exchange reaction, at least during the initial period. (auth)

26853 ORGANIC COMPOUNDS OF LANTHANIDE ELEMENTS: PREPARATION OF ACYLATES OF PRASEODYMIUM AND NEODYMIUM. Mehrotra, R. C.; Misra, T. N.; Misra, S. N. (Univ. of Rajasthan, India). J. Indian Chem. Soc., 43: 61-2(Jan. 1966).

Preparation of acetates, laurates, palmitates, and stearates of neodymium and praseodymium is described. Pure samples were obtained by crystallization from benzene solutions. In all the reactions light green crystalline compounds of praseodymium and light pink crystalline compounds of neodymium were formed. The triacetates were readily soluble in water and did not exhibit a pronounced tendency of hydrolysis in aqueous solutions. The results obtained from absorption spectra of neodymium acetate in water are in agreement with the observations of Seaton et al. (F.J.H.)

26854 EXISTENCE OF TANTALUM OXIDE TaO_2. Morawietz, H. (CIBA AG, Basel). J. Inorg. Nucl. Chem., 28: 941-4(Apr. 1966). (In German).

Mixed crystals of NbO_2 and TaO_2 were prepared and characterized by x-ray diffraction. The end of the single-phase region on the side of TaO_2 was used to estimate the free energy of the reaction: $Ta + 2Ta_2O_5 = 5TaO_2$. (auth)

26855 MAGNETIC SUSCEPTIBILITY OF $GdCl_{1.6}$ AND THE INFLUENCE OF MINOR AMOUNTS OF MAGNETIC IMPURITIES. Greiner, J. D.; Smith, J. F.; Corbett, J. D.; Jelinek, F. J. (Ames Lab., Ames, Iowa). J. Inorg. Nucl. Chem., 28: 971-8(Apr. 1966). (IS-1136).

The magnetic susceptibility of $GdCl_{1.6}$ was determined in the temperature range from 64 to 365°K by the Faraday method and from 7 to 89°K by a mutual inductance technique. Above 80°K a Curie-Weiss temperature dependence was observed. The effective moment per gadolinium ion was found to be 7.89 ± 0.03 Bohr magnetons in close agreement with the previously determined value from $GdCl_3$ and in accord with the theoretical value of 7.94 for Gd^{3+}. By inference all gadolinium electronic states above the $4f^7$ levels are paired. A Weiss constant of –166 ± 3°K resulted from the data. This large negative value indicated a strong tendency toward antiferromagnetic ordering, and an indication of an antiferromagnetic transition was found near 50°K. Ferromagnetic gadolinium impurities were present in the samples with a typical gadolinium magnetization curve resolvable at the 2700 ppM (200 μg) level. A marked difference in magnetic behavior was observed in two samples whose chemical compositions were nominally the same; this difference is explicable on the basis of a superparamagnetic contribution arising from 2100 ppM (160 μg) of finely dispersed gadolinium. (auth)

26856 CYCLOPENTADIENIDES OF YTTERBIUM(III) AND YTTERBIUM(II). Calderazzo, F.; Pappalardo, R.; Losi, S. (Cyanamid European Research Inst., Geneva). J. Inorg. Nucl. Chem., 28: 987-99(Apr. 1966).

The reaction of anhydrous ytterbium(III) chloride with sodium cyclopentadienide followed by crystallization from tetrahydrofuran (THF) gave the tetrahydrofuranate Yb $(C_5H_5)_3 \cdot C_4H_8O$ (I), which could be converted into the ammoniate $Yb(C_5H_5)_3 \cdot NH_3$ (II) by treatment with the stoichiometric amount of ammonia. Ytterbium tricyclopentadienide free from any additional Lewis base could only be obtained by using Fischer's method consisting of reacting $YbCl_3$ with KC_5H_5 in toluene. The emerald-green diamagnetic $Yb(C_5H_5)_2$ (IV) was prepared by reducing $Yb(C_5H_5)_2Cl$ with finely dispersed sodium metal. Infrared, visible, and ultraviolet absorption spectra and proton resonance spectra confirmed the proposed formulations. All the available data strongly suggested the view that the bonding between the ytterbium and the C_5H_5-rings is essentially ionic in character in all the compounds described. (auth)

26857 AQUEOUS CHEMISTRY OF ACTINIDE ELEMENTS. DETERMINATION OF THE STABILITY CONSTANT OF NITRATE, CHLORIDE, AND BROMIDE COMPLEXES OF Pu(IV). Danesi, P. R.; Orlandini, F.; Scibona, G. (CNEN, Rome). J. Inorg. Nucl. Chem., 28: 1047-54 (Apr. 1966).

The extraction of Pu(IV) from $HCl-HClO_4$, HNO_3-HClO_4, and HCl–HBr mixtures at an ionic strength of four and in some cases of six by benzene solutions of TTA was studied. The equilibrium constants for the chloride, nitrate, and bromide complexes of Pu(IV) were determined. Graphical and digital computer methods were used to calculate the β_1 from the extraction data. A comparative discussion with the literature data is given. (auth)

26858 DISSOCIATION CONSTANTS OF THE TRANSPLUTONIUM ELEMENT CHELATES OF 1,2-DIAMINOCYCLOHEXANETETRAACETIC ACID. Baybarz, R. D. (Oak Ridge National Lab., Tenn.). J. Inorg. Nucl. Chem., 28: 1055-61(Apr. 1966). (ORNL-P-1509).

The dissociation constants of the DCTA complexes with Am, Cm, Bk, Cf, Es, and Fm were determined by an ion exchange technique. The values obtained are: americium, $10^{-18.79}$; curium, $10^{-18.81}$; berkelium, $10^{-19.16}$; californium, $10^{-19.42}$; Einsteinium, $10^{-19.44}$; and fermium, $10^{-19.56}$. The Fm/Es and Es/Cf ion exchange separation factors are 1.38 and 1.21, respectively. (auth)

26859 SOLUBILITY OF LANTHANUM SULFATE IN SULFURIC ACID SOLUTIONS AT ELEVATED TEMPERATURES. Lietzke, M. H.; Stoughton, R. W. (Oak Ridge National Lab., Tenn.). J. Inorg. Nucl. Chem., 28: 1063-6 (Apr. 1966). (ORNL-P-1583).

The solubility of $La_2(SO_4)_3$ was measured in 0.234, 0.471, and 0.714 M H_2SO_4 solutions in the temperature range from 120 to 175°C. It was found that even in this case of a 3 to 2 valent salt the variation of the molality solubility product with ionic strength could be expressed by a single-parameter expression of the Debye-Hückel type, as was found in previous studies of the solubility of Ag_2SO_4 in H_2SO_4. In addition to this parameter the solubility of $La_2(SO_4)_3$ in water, which could not be measured in this temperature range due to hydrolysis, was calculated from the least squares fit of the data. (auth)

26860 DETERMINATION OF THE FORMATION COEFFICIENTS OF Be EDTA COMPLEXES. Bamberger, C.; Laguna, F. (Comision Nacional de Energia Atomica, Buenos Aires). J. Inorg. Nucl. Chem., 28: 1067-72(Apr. 1966).

The formation constants for four Be–EDTA complexes with a metal to ligand ratio of 1:1 were determined. Radiometric determinations were made of the Be distribution coefficients on an ion exchanger in the presence and absence of EDTA. The formation quotients were calculated by an equation of Schubert modified in order to obtain the four quotients simultaneously and to correct for the sorption of a cation complex by the exchanger. The values obtained are discussed and compared with previous results listed in the literature. (auth)

26861 PREPARATION AND THERMAL DECOMPOSITION OF BARIUM URANYL OXALATE AND OF BARIUM PLUTONYL OXALATE. Chackraburtty, D. M.; Jayadevan, N. C. (Atomic Energy Establishment, Trombay, India). J. Inorg. Nucl. Chem., 28: 1111-14(Apr. 1966).

Barium plutonyl oxalate and barium uranyl oxalate were prepared. Results of chemical and x-ray analyses and thermogravimetry are described. The thermal decomposition was studied on 15 to 20 mg samples in a silica thermogravimetric balance. The samples lost weight up to 100°C and there was very little change from 100 to 300°C. The decomposition of the uranyl oxalate started above 300°C and was complete at 600°C; from 600 to 900°C there was no weight change. The empirical formula of the final decomposition product was found to be $BaUO_4$ from chemical and x-ray analyses. No crystalline pattern could be obtained for the products obtained by decomposition of barium uranyl oxalate heated between 120 and 600°C. The composition of barium plutonium oxalate was $BaPuO_2(C_2O_4)_2 \times H_2O$. From x-ray diffraction patterns, the final product at 900°C was identified as cubic ABO_3 structure type. (F.J.H.)

26862 CORRELATION OF MOESSBAUER PARAMETERS WITH INFRARED AND MAGNETIC DATA. Duncan, J. F.; Golding, R. M.; Mok, K. F. (Victoria Univ., Wellington, New Zealand). J. Inorg. Nucl. Chem., 28: 1114-16 (Apr. 1966).

The use of Mössbauer techniques along with infrared and magnetic studies for investigation of compounds (Fepy4X), where py = pyridine and x = Br, Cl, I, CNO, and CNS, is described. Infrared spectroscopy, visible spectroscopy, and magnetic moment measurements were used. A parallel investigation using the Mössbauer technique to determine the parameters ΔE, (quadrupole split) and δ (chemical shift) for ^{57}Fe showed that this method was more satisfactory. The observed values showed that ΔE_Q varied from 0.43 to 0.73 mm/sec and δ from 0.52 to 0.55 mm/sec. The results showed that all the compounds were similar as far as the environments of the iron atoms are concerned, and confirmed the conclusion from the magnetic work that they were all of high spin. The spectra showed no evidence of more than one type of iron site. (F.J.H.)

26863 NEW COMPOUNDS OF THE AB_2O_6 TYPE. Blasse, G. (Philips' Gloeilampenfabrieken, Eindhoven, Netherlands). J. Inorg. Nucl. Chem., 28: 1122-4(Apr. 1966).

Compounds of the type AB_2O_6 are reported, where A are large and B are small cations (ionic radii of ~1.0 and 0.7Å, respectively). They have one of three structure types: orthorhombic $CaNb_2O_6$, orthorhombic $CaTa_2O_6$, or $CaSb_2O_6$. Materials were prepared by sintering intimate mixtures of high-purity oxides or carbonates in oxygen at 1300°C (Sb containing samples at 1250°C and Mo-containing samples at 1150°C). X-ray powder diagrams were obtained on an x-ray diffractometer using CuK_α radiation. The results are shown. In a number of cases no single-phase material of the type AB_2O_6, but two phases, namely ABO_4 (scheelite) and (rutile) were obtained. (F.J.H.)

26864 PREPARATION AND PROPERTIES OF TRANSITION METAL MOLYBDATES. VI. Doyle, W. P.; McGuire, G.; Clark, G. M. (Edinburgh Univ.). J. Inorg. Nucl. Chem., 28: 1185-90(May 1966).

Solid binary systems of molybdenum(VI) oxide with oxides of each of the following: titanium(II, III, IV), vanadium(II, III, IV, V), chromium(II[illegible]anganese(II, III, IV), cobalt(II), nickel(II), copper(I, I[illegible], niobium(IV, V), and hafnium(IV) were investigated by x-ray powder diffraction. The following compounds were identified: $VMoO_5$; V_2MoO_8; $Cr_2Mo_3O_{12}$; $Cu_6Mo_4O_{15}$, Cu_2MoO_5, and $HfMo_2O_8$. Reflectance spectra from 225 to 1000 mμ and room temperature magnetic susceptibilities were measured for $VMoO_5$, $Cr_2Mo_3O_{12}$, $MnMoO_4$, $CoMoO_4$, $NiMoO_4$, and $CuMoO_4$ and for most of the corresponding tungstates and sulfates for purposes of comparison. The results are discussed in terms of the oxygen coordination of the transition metal cation. (auth)

26865 FORCE CONSTANTS OF METAL HEXAFLUORIDES. Thakur, S. N.; Rai, D. K. (Banaras Hindu Univ., Varanasi, India). J. Mol. Spectros., 19: 341-8(Apr. 1966).

The simple and modified UBFF was applied to thirteen octahedral metal hexafluorides. The force constants were adjusted by a least squares method. The force constants showed certain regularities. The covalent character of the metal fluoride, metal chloride, and metal bromide bonds is discussed. (auth)

26866 SPECTROSCOPY AND COORDINATION CHEMISTRY OF EUROPIUM CHELATE SOLUTIONS: CONCENTRATION AND SOLVENT EFFECTS. Samelson, H.; Brecher, C.; Lempicki, A. (General Telephone and Electronics Labs. Inc., Bayside, N. Y.). J. Mol. Spectros., 19: 349-71(Apr. 1966).

The emission spectra of three β-diketone chelates of europium were studied in five different solvents over a wide range of concentrations. The number of bidentate ligands coordinated to the europium can vary from one to four, and the constants for various equilibria established between these species in solution were determined spectroscopically for one chelate-solvent system. These equilibria were strongly dependent both on the concentration and on the chemical properties of the solvent. The molecular geometry of the chelate and its effects on the europium were similarly solvent dependent. Some laser implication of these results are discussed. (auth)

26867 CONSIDERATIONS ON THE DISTRIBUTION OF IONS BETWEEN AN ORGANIC SOLUTION OF ALKYLAMMONIUM SALTS AND AN AQUEOUS SOLUTION OF INORGANIC SALTS IN THE PRESENCE OF HOMOPOLYMERS AND HETEROPOLYMERS IN THE ORGANIC PHASE.

Scibona, G. (Massachusetts Inst. of Tech., Cambridge. Centro Studi Nucleari Casaccia, Rome). Contract AT(30-1)905. J. Phys. Chem., 70: 1365-71(May 1966). (MIT-905-38).

The distribution of a monovalent simple anion, Y^-, or of a monovalent metal complex anion, MX^-_{n+1}, between an aqueous solution of the supporting electrolyte CX and a water-immiscible solution of an alkylammonium salt $\overline{RX}$ is described with regard to the presence in the organic phase of the homopolymers $\overline{(RX)}_i$, $\overline{(RY)}_j$ and of the heteropolymers $\overline{(RX)}_a\overline{(RY)}_b$. A set of equations was derived that show the dependence of the experimental distribution data on the concentration of the alkylammonium salt and the extracted anion. A successful reinterpretation of the data existing in the literature on the distribution of $UO_2(NO_3)_2$ between aqueous nitrate solution and alkylammonium nitrate solutions was carried out. The presence of a mixed tetramer and of monomer terms seems to fit the experimental data. (auth)

26868 CONDENSED-PHASE BEHAVIOR OF THE ALUMINUM CHLORIDE–ZIRCONIUM CHLORIDE SYSTEM. Shor, A. J.; Smith, William T. Jr.; Bredig, M. A. (Oak Ridge National Lab., Tenn. Univ. of Tennessee, Knoxville). J. Phys. Chem., 70: 1511-15(May 1966). (ORNL-P-1776).

According to thermal, differential thermal, and x-ray analysis, Al_2Cl_6 and $ZrCl_4$ form a simple eutectic system, without solid intermediary compounds but possibly with some limited solid solution. The composition of the eutectic at 165°C is ~ 75 mole % Al_2Cl_6. In disagreement with earlier literature data, visual observation above the liquidus showed the presence of only one liquid phase. Semiquantitative interpretation, with the use of the heats of fusion of the components, of the liquidus in terms of activities suggested that these largely molecular chlorides interact in the liquid to form mixtures of essentially unionized complex molecules $ZrCl_4 \cdot (AlCl_3)_n$, n = 1, 2, 3, and 4, with higher values of n possible at high aluminum chloride concentration. (auth)

26869 GRAVIMETRIC ADSORPTION STUDIES OF THORIUM OXIDE. II. WATER ADSORPTION AT 25.00 DEG. Fuller, E. L. Jr.; Holmes, H. F.; Secoy, C. H. (Oak Ridge National Lab., Tenn.). J. Phys. Chem., 70: 1633-6(May 1966). (ORNL-P-1832).

The complex nature of water adsorption on thorium oxide was studied using a sensitive microbalance. High-temperature sintering appeared to produce a material that predominantly presents the 100 cubic face to the surface, upon which there are three distinct modes of adsorption. There is a rapid chemisorption with formation of surface hydroxyl groups, which are slowly hydrated. In addition and as a precursor for surface hydration, physical adsorption occurs. (auth)

26870 INTERPRETATION OF THE SOLUTION ABSORPTION SPECTRA OF THE $(PuO_2)^{2+}$ AND $(NpO_2)^+$ IONS. Eisenstein, J. C. (National Bureau of Standards, Washington, D. C.); Pryce, M. H. L. J. Res. Nat. Bur. Stand., 70A: 165-73(Mar.-Apr. 1966).

A model for the electronic configuration of ions of the uranyl type was previously proposed. The solution absorption spectra of $(PuO_2)^{2+}$ and $(NpO_2)^+$ ions are interpreted on the basis of this model. The interpretation is based on exact calculations, and on plausible arguments about the strengths and widths of the absorption peaks. If suitable values are chosen for the Coulomb integrals, the spin-orbit coupling constant, and the ligand field parameters, then the calculated energy levels agree with the observed positions of the absorption peaks. (auth)

26871 VAPOR PRESSURE AND HEAT OF SUBLIMATION OF RHENIUM. Plante, E. R.; Szwarc, R. (National Bureau of Standards, Washington, D. C.). J. Res. Nat. Bur. Stand., 70A: 175-9(Mar.-Apr. 1966).

The vapor pressure of rhenium was measured by the Langmuir method in the temperature range from 2350 to 3050°K using a vacuum microbalance. The least squares line through the four series of data points is 4.5756 log P(atm) = 32.26 – 180700/T. Least squares lines for each of the four series yield heats and entropies of sublimation higher than the corresponding third law values. The vapor pressure equation based on the average heat and entropy is: 4.5756 log P(atm) = 33.36 – 183500/T. The selected third law heat of sublimation, ΔH°_s (298) is 185.9 kcal mol^{-1}. The equation recommended for the vapor pressure is 4.5756 log P(atm) = 31.86 – 180200/T based on the mean third law heat and tabulated values for the entropies and enthalpies. (auth)

26872 SYNTHESES AND OBSERVATIONS OF SOME AMINE–POLYCARBOXYL ACIDS COMPLEXES OF YTTRIUM. Adachi, Gin-ya; Shiokawa, Jiro; Ishino, Toshio (Osaka Univ.). Nippon Kagaku Zasshi, 87: 346-50(Apr. 1966). (In Japanese).

Y–EDTA(1 : 1), Y–NTA(1 : 1), Y–HEDTA(1 : 1), Y–DTPA (1 : 1, 1 : 2), and Y–IDA(2 : 3) were synthesized by direct reaction of yttrium oxide with corresponding amine-polycarboxylic acids in aqueous solution. The complexes were studied by means of infrared, pH titration, and x-ray diffraction measurements. Infrared and pH titration studies suggested that coordination bonds between yttrium ion and carboxyl groups had ionic characters and that one of the four carboxyl groups of the ligand in Y–EDTA(1 : 1) and at least one of the five carboxyl groups in Y–DTPA(1 : 1) remained uncoordinated to the central yttrium ion, while all of the carboxyl groups of other complexes coordinated to it completely. (auth)

26873 DEHYDRATION OF YTTRIUM HYDROXIDE. Adachi, Gin-ya; Shiokawa, Jiro; Ishino, Toshio (Osaka Univ.). Nippon Kagaku Zasshi, 87: 351-5(Apr. 1966). (In Japanese).

Dehydration of yttrium hydroxides, prepared from aqueous solutions of yttrium chloride with sodium hydroxide or ammonia, was studied by means of differential thermal analysis and thermobalance and x-ray diffraction measurements. Yttrium hydroxide, prepared by the sodium hydroxide process was a fine crystalline powder, whereas prepared by ammonia, it was in an amorphous state. Crystalline yttrium hydroxide decomposed through two steps to the oxide at (260 to 360°C a weight loss of 13.5% and at 450 to 540°C a weight loss of 7%). Amorphous yttrium hydroxide showed no definite composition and no definite behavior of dehydration was observed. (auth)

26874 SUBLIMATION PRESSURES OF REFRACTORY FLUORIDES. Kent, R. A.; Zmbov, K.; McDonald, J. D.; Besenbruch, G.; Ehlert, T. C.; Bautista, R. G.; Kana'an, A. S.; Margrave, John L. (Rice Univ., Houston, Tex.). pp 249-55 of Nuclear Applications of Nonfissionable Ceramics. Boltax, Alvin; Handwerk, J. H. (eds.). Hinsdale, Ill., American Nuclear Society, 1966.

Studies of the sublimation of refractory fluorides by Knudsen and/or Langmuir measurements utilizing a semimicrobalance and a mass spectrometer provided the identities of the vapor species, absolute vapor pressures, and heats of sublimation for MgF_2, CaF_2, SrF_2, BaF_2, ScF_3, VF_2, VF_3, CrF_2, MnF_2, FeF_2, CoF_2, NiF_2, CuF_2, YF_3, CdF_2, LaF_3, CeF_3, DyF_3, HoF_3, and ErF_3. Atomization energies and average bond energies were calculated. Reduced systems, in which subfluorides are generated, were also studied. (auth)

26875 COMPATIBILITY OF METALS AND CERAMICS. Cunningham, G. W. (Battelle Memorial Inst., Columbus, Ohio). pp 279-91 of Nuclear Applications of Nonfissionable Ceramics. Boltax, Alvin; Handwerk, J. H. (eds.). Hinsdale, Ill., American Nuclear Society, 1966.

A study was made of metal-ceramic systems for use at temperatures above 1800°C. Results showed that several factors must be recognized: the higher the temperature, the greater the probability that chemical equilibrium will be reached; the pressure or absence of gases down to pressures of 10^{-11} atm is important and must be considered; material solubility, even at low levels, is an important driving force; defect structures contribute significantly to the total free energy and also permit collection of an appreciably larger amount of impurities than is possible

by simple solution; and use of complex alloys introduces the concept of interaction parameters, i.e., in a complex alloy the activity of a minor constituent may differ greatly from the activity of the same amount of the same constituent in a binary alloy. A guide for selection of compatible materials is presented. (auth)

26876 URANIUM DIOXIDE DEPOSITION FROM GASEOUS PHASE BY HYDROLYSIS OF URANIUM TETRACHLORIDE. **Adamski, T.; Rykowski, St. (Instytut Badan Jadrowych, Warsaw). Nukleonika, 11: 7-11(1966). (In Polish).**

Hydrolysis of uranium tetrachloride in the gaseous phase was performed. Crystalline uranium dioxide with a lattice constant $a_0 = 5.4682$ Å was obtained. It was shown to be possible to produce uranium dioxide coatings on grains of a model substance in a fluidized bed by this method. (auth)

26877 DIAGRAMS OF ELECTROCHEMICAL EQUILIBRIA IN U-H_2O-CO_2 SYSTEM AT 25 DEG. **Letowski, Franciszek; Niemiec, Jan (Instytut Chemii Nieorganiczne], Wroclaw). Nukleonika, 11: 13-28(1966). (In Polish).**

The diagrams of electrochemical equilibria E-pH for the system U-H_2O-CO_2 at 25°C are presented for which the total carbonate activities $[(H_2CO_3) + (HCO_3^-) + (CO_3^{--})]$ in solutions equal to: 10^{-3}, 10^{-2}, 10^{-1}, 10^0, and $10^{0.6}$ were accepted. Additionally, three-dimensional models of equilibria in E-pH-log $[(H_2CO_3) + (HCO_3^-) + (CO_3^{--})]$ coordinate system and thermodynamical corrosion conditions of uranium in carbonate solution are given. (auth)

26878 ISOTOPIC EXCHANGE AS A CRITERION OF THE STRUCTURE OF OCTAHEDRAL $[Me(CNS)_6]^{n-}$ COMPLEXES. I. ISOTOPIC EXCHANGE IN THE SYSTEM $[Cr(CNS)_6]^{3-}$-$^{14}CNS^-$. **Wajda, Stanislaw; Pruchnik, Florian (Univ., Wroclaw). Nukleonika, 11: 35-46(1966). (In Polish).**

The kinetics of radiocarbon exchange in the hexathiocyanatochromate(III) ion was studied. It was found that the exchange proceeds according to the S_{N2} association mechanism since the reaction order is equal to 2. On the basis of the existence of an induction period and its changes according to reagent concentrations and reaction order, the exchange mechanism is given. The data obtained enabled the activation energy of the exchange process to be calculated. (auth)

26879 CHEMISTRY OF WEIGHABLE AMOUNTS OF POLONIUM AND PROTACTINIUM. **Bagnall, K. W. (Atomic Energy Research Establishment, Harwell, Eng.). Radiochim. Acta, 5: 1-5(Mar. 1966).**

Some of the problems involved in chemical studies with polonium (138.4-day ^{210}Po) and the much less intensely radioactive protactinium (32,600-yr ^{231}Pa) are discussed and the handling of these two α-active isotopes is briefly described. The chemistry of polonium and protactinium, particularly the halides and nitrates, is reviewed in the light of their positions in the Periodic Table. (auth)

26880 SOLID-STATE CHEMISTRY OF PROTACTINIUM OXIDE. **Keller, Cornelius (Technische Hochschule, Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). Radiochim. Acta, 5: 5-8(Mar. 1966). (In German).**

Solid-state reactions of PaO_2 and Pa_2O_5 with oxides of some elements of the first to fourth normal and third to fifth transition group of the periodic system were studied. The structural types of the compounds obtained were partly characteristic of the pentavalent actinides, but also of the elements Nb and Ta. Preparation conditions and lattice constants of the ternary oxides are discussed. (auth)

26881 TEMPERATURE DEPENDENCE OF HETEROGENEOUS ISOTOPIC EXCHANGE ON THE SURFACE OF IONIC CRYSTALS. **Lieser, K. H.; Guetlich, Ph.; Rosenbaum, I. (Technische Hochschule, Darmstadt, Ger.). Radiochim. Acta, 5: 38-42(Mar. 1966). (In German).**

The determination of isotopic exchange between labeled strontium or sulfate ions at the surface of strontium sulfate showed that the number of exchangeable surface ions is strongly temperature dependent between 0 and 40°C. This was attributed to the fact that the water molecules at the ionic crystal surface partly gain their full mobility only far above 0°C. In a methanol/water mixture (solidification point −40°C) there was no isotopic exchange below −18°C. This was explained by enrichment of water molecules at the crystal surface. The activation energies of exchange were found to be 12.0 kcal/mole for $BaSO_4/Ba^{2+}$, 15.7 kcal/mole for $BaSO_4/SO_4^{2-}$, 5.2 kcal/mole for $SrSO_4/Sr^{2+}$, and 9.0 kcal/mole for $SrSO_4/SO_4^{2-}$. These activation energies are attributed to the fact that the ions leaving the surface must overcome the lattice forces and the ions entering the surface must at least partially strip off their hydration shell. (auth)

26882 REDUCTION OF PLUTONIUM(IV) IN SULPHURIC ACID SOLUTION TO PLUTONIUM(III) WITH HYDROGEN. **Rao, C. L.; Neelakantan, K. (Atomic Energy Establishment, Trombay, India). Radiochim. Acta, 5: 48-9(Mar. 1966).**

Reduction of Pu(IV) to Pu(III) in sulfuric acid solution with hydrogen is described. The acidity of the Pu solution and the concentration of Pu were determined by titration, with standard sodium hydroxide solution and by alpha counting, respectively. The extent of Pu(IV) reduction was estimated by determining the absorption peak values of Pu(IV) before and after reduction at the same wavelength. Results are shown for solutions with Pu concentration of 0.005M and sulfuric acid concentration varying from 0.25 to 10.5M. The results are reproducible only when a fresh electrode is used for each experiment. It was found that a maximum of 96% reduction occurred at the lowest concentration of sulfuric acid and decreased with increasing sulfuric acid concentration. (F.J.H.)

26883 INVESTIGATION OF DIALKYLPHOSPHATE COMPLEXES OF THORIUM AND RARE EARTH ELEMENTS BY A KINETIC METHOD. **Sheka, Z. A.; Sinyavskaya, E. I. Radiokhimiya, 7: 596-603(1965). (In Russian).**

The formation and stability of dibutyl phosphate complexes of thorium and rare earth elements were investigated. The structure and stability of these complexes were derived from studying the kinetics of oxidation of potassium iodide catalyzed by thorium and rare earth elements. In all experiments the total volume was 25 ml. In experiments with thorium, 5 ml of 0.2 molar acetate buffer were added to an aqueous solution of thorium chloride. This was succeeded by a solution of dibutyl phosphoric acid, potassium iodide, and starch. After the introduction of hydrogen peroxide, the mixture was held at 25 ± 0.01°C and the optical density of the solution was measured using a photoelectrocolorimeter. The final concentration of potassium iodide was 4×10^{-4} molar and that of hydrogen peroxide was 3.4×10^{-4} molar. It was found that n-dibutyl orthophosphoric acid (HA) reacts with thorium chloride to form a complex of a general formula: $ThOHA^{2+}$. This complex is inactive as a catalyst for oxidation of potassium iodide by hydrogen peroxide. The logarithm of the stability constant of this complex at a zero ionic strength is equal to 5.06 ± 0.06. The dependence of the logarithm of stability constants ($\lg\beta$) of complexes of rare earth elements with dibutyl phosphoric acid (general formula LnA^{2+}) on the specific atomic number of elements is shown. (ATD)

26884 ELECTROLYTIC DEPOSITION OF SMALL QUANTITIES OF URANIUM FROM SOLUTIONS. **Roslyakov, V. S.; Ezhova, M. P. Radiokhimiya, 7: 625-7(1965). (In Russian).**

A rapid method for quantitative electrolytic deposition of uranium from solutions containing as little as 5 mg uranium is described. For quantitative uranium deposition (5 mg), the optimum conditions of electrolysis are: 0.4 molar solution of ammonium oxalate, 10 to 15 ml electrolyte volume, electrolyte pH = 9, electrolysis duration 15 min, 4 amps d-c current, diameter of the copper cathode ~35 mm, and a 5 mm gap between electrodes. (ATD)

26885 MOESSBAUER EFFECT AND ITS CHEMICAL APPLICATIONS. **Smith, J. W. (Bedford Coll., London). Sci. Progr. (London), 54: 103-15(Spring 1966).**

The study of the resonant absorption of γ rays by certain specific nuclei is proving to be an important new physical weapon for studying problems of chemical structure. An

outline is given of the theory underlying splittings and displacements of the absorption frequencies produced by the environment in which the absorbing nucleus is situated. The applications of the method are illustrated by reference to various compounds of iron. (auth)

26886 STEARIC ACID MONOLAYERS ON HEAVY WATER. Dreher, K. D.; Sears, D. F. (Tulane Univ., New Orleans). Trans. Faraday Soc., 62: 741-9(Mar. 1966).

Force-area, surface potential-area, and viscosity-surface pressure data were obtained for stearic acid monolayers on water and heavy water (DOD) at 15, 25, and 37°C. These data showed that substitution of DOD for HOH increases the surface potential of stearic acid monolayers and increases surface viscosity. However, no differences in force-area curves were detected between monolayers on HOH and DOD. (auth)

26887 COMPLEXES OF RARE EARTH ELEMENTS WITH ACETYLACETONE AND 1,10-PHENANTHROLINE OR 2,2'-DIPYRIDYL. Kononenko, L. I.; Melent'yeva, E. V.; Vitkun, R. A.; Poluektov, N. S. Ukr. Khim. Zh., 31: 1031-5(1965).

Ternary compounds formed by a rare earth metal with acetylacetone (AA) and phenanthroline (Phen) or dipyridyl (Dip) were synthesized from Y, La, Pr, Nd, Sm, Eu, Gd, Tb, and Er, and their composition and properties were studied. Chemical analyses showed that the ratio Me:Dip:AA is very close to 1:1:3. The probable structure of such ternary compounds with Eu and 2,2'-dipyridyl is given. In connection with the use of rare earth β-diketonates in laser applications, the fluorescence characteristics of simple and ternary europium and terbium acetylacetonates were compared, and the spectra of the $Eu^5D_0 - {}^7F_2$ and $Tb^5D_4 - {}^7F_5$ bands are illustrated. It was found that the presence of acetylacetone in the molecule of the complex increases the fluorescence brightness of terbium and reduces the fluorescence of europium. The fluorescence spectra of the dipyridyl complexes are similar to those of the phenanthroline complexes. (ATD)

26888 PREPARATION OF HAFNIUM TETRABROMIDE AND TETRAIODIDE. Vinarov, I. V.; Kovaleva, E. I.; Khromova, N. P. (Inst. of General and Inorganic Chemistry, Academy of Sciences, Ukrainian SSR). Ukr. Khim. Zh., 31: 1107-9(1965). (In Russian).

A new technique was developed for preparing HfI_4 and $HfBr_4$ from the elements. The reaction vessel was made of molybdenum glass, and all the operations (bromination, sublimation, and condensation of the tetrabromide) were carried out in sealed glass vessels. $HfBr_4$ was obtained in 80–90% yield based on hafnium and 80–92% based on bromine, and contained the following impurities (in %): Fe 0.009; Ti 0.004; Al 0.012; Co 0.028; and SiO_2 0.11. HfI_4 was obtained in 86.8% yield based on hafnium and 92% based on iodine, and contained the impurities (in %): Fe 0.011; Ti 0.008; Al 0.012; Ca 0.03; and SiO_2 0.2. Both products were thus of reagent-grade purity. (ATD)

26889 STRUCTURE OF THE A-FORM OF THE SESQUIOXIDES OF THE RARE EARTHS. II. STRUCTURE INVESTIGATIONS ON Nd_2O_3. Mueller-Buschbaum, H. (Univ., Munster, Ger.). Z. Anorg. Allg. Chem., 343: 6-10(Mar. 1966). (In German).

The structure of the A-form of rare earth sesquioxides was investigated again. The symmetries and systematic absences found with single-crystal photographs of Nd_2O_3 were entirely identical with those of La_2O_3. Therefore, here the same kind of "micro-twinning" occurs as described for La_2O_3. (auth)

26890 CONTRIBUTIONS TO THE CHEMISTRY OF THE RARER ELEMENTS. THE HYDROLYSIS OF SCANDIUM CARBIDE WITH DILUTE ACIDS. Petru, F.; Hajek, B.; Brozek, V. (Institut fuer Anorganische Chemie, Prague). Z. Chem., 6: 32-3(Jan. 1966). (In German).

Preparations of ScC from Sc_2O_3 and C were carried out at 1850°C for 50 min at 6 atm. Analysis yielded the formula ScC, and Debye-Scherrer patterns indicated a cubic structure with a lattice constant a = 4.50 kX. The carbide is stable in water at low temperatures, but at high temperatures gaseous CH_4 is produced. Efficient production of CH_4 is achieved by the use of dilute acids (20% H_2SO_4, 10% HCl). Identification of CH_4 was by comparison of ir spectra with a standard. The quantity of methane produced corresponds to a formula of Sc_4C_3, with a 2% excess. Production of methane in this hydrolysis would indicate the presence of a salt-like carbide analogous to Al_4C_3. The excess C which raises the ratio to 1:1 appears to be bound some other way. Perhaps a solid Sc_4C_3-graphite phase is present. (BBB)

26891 ON A SOLID COMPLEX COMPOUND IN THE SYSTEM $Th(NO_3)_4$-TRIISOBUTYLPHOSPHATE-HNO_3. Horx, M.; Rost, J. (VEB Elektrochemisches Kombinat Bitterfeld, Ger.). Z. Chem., 6: 33-4(Jan. 1966). (In German).

Solid triisobutyl phosphate-$Th(NO_3)_4$ complex was prepared by dispersing triisobutyl phosphate for 4 hours in the $Th(NO_3)_4$ solution. After standing 24 hours the precipitate was washed with 100 to 150 ml 4N HNO_3 and dried at room temperature in air. The distribution curves for $Th(NO_3)_4$ as a function of the concentration of triisobutyl phosphate in the organic phase (xylene) are illustrated. The slope of the line is a function of the ratio of the two components of the resulting complex compound. Distribution coefficients for a 0.5M $Th(NO_3)_4$ solution and various concentrations of the ester are presented for various amounts of added NO_3^- (HNO_3, $LiNO_3$, $Fe(NO_3)_2$, $Mg(NO_3)_2$); added materials have little effect at low concentration. At a certain concentration ratio, crystalline $Th(NO_3)_4 \cdot 3$ triisobutyl phosphate separates; the maximum precipitation occurs between the ratios 2.5 and 3. The product may be recrystallized from CCl_4, mp 96–98°C; it is produced by exceeding the solubility product and is formed at the expense of $Th(NO_3)_4 \cdot 2$ triisobutyl phosphate. (BBB)

26892 DIFFUSION OF HT, DT, AND T_2 IN H_2 AND D_2 AT 24°C. Reichenbacher, W.; Mueller, P.; Klemm, A. (Max-Planck-Institut fuer Chemie, Mainz). Z. Naturforsch., 20a: 1529-36(Nov. 1965). (In German).

The diffusion coefficients (D) of HT, DT, and T_2 traces in H_2 and D_2 were measured at 24°C and 1 atm. Deviations from the $D \sim \mu^{-1/2}$ law (μ = reduced mass of the diffusion partner) were found, which were significantly smaller than those reported in previous publications. By a least-mean-squares calculation the three coefficients of the representation $2(\sqrt{\mu}D)_{I,II} = 0.111\ m_{I,II} + 0.049\ (m_{13}^2 - m_{24}^2) + 0.083\ (m_{AC}^2 + m_{BD}^2 - m_{ac}^2 - m_{bd}^2)$ were obtained. Generally $x_{ik} = (x_i - x_k)/(x_i + x_k)$ is valid. I and II designate mixtures and 1, 2, 3, and 4 designate molecules. For the masses $m_I = m_A + m_C$, $m_3 = m_B + m_D$, $m_2 = m_a + m_c$, $m_4 = m_b + m_d$, $m_I = m_1 + m_3$, $m_{II} = m_2 + m_4$ are valid. In connection with the deviation from the $D \sim \mu^{-1/2}$ law, the differences of the nuclear distances calculated from the molecular spectra, the predictions of the crude spherical model, and the contribution of the second approximation of the kinetic gas theory are discussed. (tr-auth)

26893 TUNGSTEN TRIOXIDE AND ITS REACTIONS WITH OXIDES OF DIVALENT METALS. II. THE REACTION $CuO + WO_3 \rightarrow CuWO_4$. Leute, Volkmar (Univ., Munich). Z. Phys. Chem. (Frankfurt), 48: 319-39(Mar. 1966). (In German).

The kinetics of the solid-state reaction $CuO + WO_3 \rightarrow CuWO_4$ was investigated microscopically in the temperature range between 690 and 930°C. Single crystals or compacts of the pure initial phases were used as reaction partners. The reaction product always precipitated as polycrystalline although the crystal load was dependent on the reaction temperature. Investigations using an electron beam microanalyzer showed that the reaction product was $CuWO_4$. Aside from a temperature-dependent induction time at the beginning of the reaction, the reactions of single-crystal WO_3 followed a parabolic time law between 690 and 805°C. The reaction in this region can be described by the diffusion equation $D = 3.1 \times 10^{-2} e^{-37.5 \times 10^3/RT}$ (cm^2/sec). The activation energy is therefore strongly dependent on the contact between the reacting phases. The chances of detecting an isotropy of the velocity in solid-body reactions are discussed. (tr-auth)

26894 INTERACTION OF TRI- AND HEXAVALENT PLUTONIUM WITH ARSENAZO III. Nemodruk, A. A.; Kochetkova, N. E. Zh. Anal. Khim., 21: 427-32(1966). (In Russian).

Plutonium in its tervalent and hexavalent states reacted with arsenazo(III) in a wide range of nitric acid and hydrochloric acid concentrations. The sensitivity of the reaction depends on the acidity of solutions. In strongly acid solutions tervalent plutonium (due to its oxidation by air oxygen) and hexavalent plutonium (being reduced by the arsenazo(III) excess) gradually change their valency to the tetravalent state. For rapid and quantitative transition of other valent states of plutonium to its tetravelent state a mixture of salts of bivalent and tervalent iron should be added to the analyzed solutions. (auth)

26895 NEODYMIUM SALICYLATES. Ermolenko, V. I. (Inst. for General and Inorganic Chemistry, Academy of Sciences, Ukrainian SSR). Zh. Neorg. Khim., 10: 2617-29(Dec. 1965). (In Russian).

Neodymium salicylate was obtained by mixing equivalent amounts of aqueous solutions of neodymium chloride and sodium salicylate, filtering the precipitate, washing it with water, acetone and ether, and drying it for 6 hours at 85°C. Measurements were made for solubility and electrical conductivity, potentiometric titration with alkali, extraction, third-order electrodes, absorption spectra, as well as density. From data on the solubility of neodymium salicylate in sodium salicylate at 25°C and an ionic strength of I = 1, the fourth instability constant for the complex neodymium salicylate $NdSal_4^-$, was calculated as $K_4 = 0.14$. In methyl alcohol the solubility of neodymium depends strongly on the concentration of salicylic acid. The electrical conductivity of neodymium salicylate in methyl and n-butyl alcohol was studied as a function of the dilution and the dissociation constants were calculated as $K_1 = (2.4 \pm 1.0) \times 10^{-5}$ in methanol and $K_1 = (1.0 \pm 0.5) \times 10^{-5}$ in n-butanol at 25°C and an ionic strength of 0.001. The distribution constant of neodymium salicylate between pure tributyl phosphate and a 0.10 molar aqueous solution of sodium salicylate was found to be equal to 100 at 20°C. (ATD)

26896 COMPLEX FORMATION BETWEEN YTTRIUM AND RARE EARTH ELEMENTS WITH SERINE. Panasyuk, V. D.; Golub, V. A. (Kiev State Univ.). Zh. Neorg. Khim., 10: 2732-6(Dec. 1965). (In Russian).

Complex formation between yttrium and six rare earth elements (Gd, Tb, Ho, Er, Yb, and Lu) and hydroxylalanine in aqueous solutions is reported. The investigation was carried out by the pH-potentiometric alkaline titration of hydroxylalanine, with a varying concentration of metal and a constant concentration of additive. The starting materials were the nitrates and, in some cases, the chloride salts of Y, Gd, Tb, Ho, Er, Yb, and Lu which had previously been analyzed for their content of metal and anion. It was found that the above elements with hydroxylalanine in aqueous solutions form complexes with a 1:1 ratio of components. Stability constants were determined for the complexes formed. Comparison of the results with data from the literature shows that hydroxylalanine forms complexes with the above rare earth elements which are less stable and which have a lower coordination number than complex compounds of the rare earth elements with alpha-amino- and beta-oxyacids. (ATD)

26897 NEODYMIUM CITRATES. Verenikin, V. B.; Astakhov, K. V.; Malanichev, F. G. Zh. Neorg. Khim., 10: 2760-3(Dec. 1965). (In Russian).

The experimental investigations were carried out by several methods: a series of solutions with a constant content of the central ion and a varying additive; a series of solutions with a constant content of the additive and a varying content of the central ion; and a series with a constant ratio of the concentrations of the central ion and the additive at varying pH values. All the experiments were made at a temperature of 20–22°C. The ionic strength of the solution was determined in almost all cases by the ions and the complex-forming substance. Buffer solutions were not used to eliminate side processes of complex formation. pH values used were 1.0, 3.0, 4.0, and 5.5. Study of complex formation between neodymium ions and citric acid by spectrophotometry made it possible to establish the composition of the complexes formed by the ions of the rare earth elements in complex systems. By using isomolar solutions with a constant content of the central ion, and solutions with a constant content of the additive, it was established that neodymium ions form a number of complexes, including polynuclear complexes. (ATD)

26898 REACTION OF Sc_2O_3 WITH OXIDES OF THE ALKALINE EARTH METALS. Komissarova, L. N.; Pokrovskii, B. I. (Moscow State Univ.). Zh. Neorg. Khim., 10: 2826-7(Dec. 1965). (In Russian).

The synthesis of several compounds of different compositions belonging to the barium oxide-scandium oxide system is described. Starting materials were chemically pure barium carbonate and scandium oxide with an impurities content of less than 0.1%. A mixture of barium carbonate and scandium oxide (0.5 grams) containing 3% excess barium carbonate over the calculated amount was ground with ethyl alcohol, pressed into tablets under a pressure of 3000 kg/cm^2 and subsequently annealed for 10 hours at 1300°C and then for 2 hours more at 1500°C. Phase analysis of the sintered samples was done by x-ray methods. The stability in air of the synthesized products was simultaneously tested. Two stable compounds were observed with the compositions $BaO \cdot Sc_2O_3$ and $3BaO \cdot 2Sc_2O_3$. It was possible to postulate the existence of still another compound with a high BaO content which is slightly hydrolyzed in air, since none of the lines of the new phase can reliably be related either to BaO or to possible products of its hydrolysis. The compounds of BaO and Sc_2O_3 which were obtained, as well as $CaSc_2O_4$ and $SrSc_2O_4$ synthesized by an analogous method, were melted in a graphite furnace in a helium atmosphere. The values of the melting temperatures are given. (ATD)

26899 NEW BORIDE PHASE WITH A HIGH METALLIC CONTENT IN THE LANTHANUM–BORON SYSTEM. Markovskii, L. E.; Vekshina, N. V. (Inst. for Applied Chemistry, Leningrad). Zh. Prikl. Khim., 38: 1945-9 (Sept. 1965).

The use of hydrolytic separation for discovery of new boride phases of lanthanum is described. Reaction of lanthanum and boron was carried out by sintering a pressed mixture of their powders at temperatures from 800 to 1300°C. The powders used were prepared from ingots containing 99.8% lanthanum and 99% pure finely crystalline boron obtained by refining amorphous boron in vacuum at 2000°C. The reaction products were subjected to x-ray examination and to chemical phase analysis. Experiments showed that LaB_4 and LaB_6 are practically insoluble in very dilute hydrochloric acid, and that only lanthanum tetraboride is dissolved during boiling. Lanthanum hexaboride (like LaB_4) is readily soluble in nitric acid. Based on this fact, samples were treated for about one hour in dilute hydrochloric acid (1:10) until disolution stopped. The solid residue obtained was further treated with boiling concentrated hydrochloric acid and the product, insoluble in hydrochloric acid, was treated with strong nitric acid. The solutions obtained were analyzed for boron and lanthanum. The experiments showed that, during reactions of weak hydrochloric acid with a number of samples obtained by the sintering of metallic lanthanum with boron, an energetic reaction accompanied by the evolution of boron hydrides occurred. Experimental data indicated that the amounts of lanthanum and boron in the solution correspond to the ratio La:B = 2:1. This ratio was maintained over a wide range of lanthanum and boron concentrations in the original charge. Analysis indicated that, in addition to the known borides, LaB_4 and LaB_6, there also exists a lower boride of the composition, La_2B. This compound is readily soluble in very dilute hydrochloric acid with the evolution of a large amount of boron hydrides up to 8%. It was established that, in the series $La_2B - LaB_4 - LaB_6$, the chemical stability of the borides increases with the boron content in the boride phase. The highest content of La_2B in the melts was attained with a ratio in the reaction mixture equal to La:B = 1:2 and a calcining temperature of 800°C. (ATD)

26900 LANTHANUM SELENIDES AND OXYSELENIDES. Obolonchik, V. A.; Mikhlina, T. M. Zh. Prikl. Khim., 38: 2100-3(Sept. 1965). (In Russian).

The reaction of lanthanum chloride with hydrogen selenide was studied. The method can be illustrated by the following equations: $2LaCl_3 + 3H_2Se \rightarrow La_2Se_3 + 6HCl$, and $2LaCl_3 + 4H_2Se \rightarrow La_2Se_4 + 6HCl + H_2$. Hydrogen selenide was synthesized from 99.998% pure selenium in a quartz reactor and was passed over lanthanum powder at temperatures on the order of 300 to 1200°C. Results of the reaction are presented in tables. To obtain lanthanum diselenide, the temperature was gradually increased to 750 to 800°C and was held at this level for 2 hr. To obtain hydrogen sesquiselenide, the temperature was raised to 1100 to 1150°C and held at this level for 2 to 2.5 hr. To study the stability of La_2Se_3 and La_2Se_4, and to obtain a phase with a lower content of selenium, studies were carried out on the hydrogenation of lanthanum sesquiselenide. At temperatures of 350 to 380°C, a black product corresponding by analysis to lanthanum sesquiselenide was obtained. This phase is stable up to 550°C; at higher temperatures (on the order of 900°C) the known brick-colored lanthanum sesquiselenide was evolved. The data indicated that lanthanum oxyselenide, La_2O_2Se, is obtained in the reaction of lanthanum oxide with selenium in an inert atmosphere at temperatures of 1100 to 1200°C. The action of hydrogen selenide on lanthanum oxide or chloride at 700 to 800°C leads to the production of La_2Se_4, while at temperatures of 1100 to 1200°C it leads to the production of lanthanum sesquiselenide, La_2Se_3. On heating lanthanum sesquiselenide to 1200°C in a stream of hydrogen, the selenium content decreases to a limiting value corresponding to lanthanum sesquiselenide. (ATD)

26901 THERMAL STABILITY OF POLYMORPHIC UO_3. Beketov, A. R.; Vlasov, V. G. Zh. Prikl. Khim., 38: 2103-5(Sept. 1965). (In Russian).

The results of thermographic, kinetic, and x-ray studies of the processes of decomposition of amorphous UO_3, alpha-UO_3, beta-UO_3, and gamma-UO_3 are presented. Amorphous UO_3 was prepared by calcining uranium peroxide for 3 hr at 350°C in a stream of oxygen, with supplementary heating for 1 hr at 400°C. Alpha-UO_3 was prepared by calcining uranium peroxide in air for 3 hr at 550°C. Beta-UO_3 was prepared by calcining ammonium diuranate in air at 400°C for 3 hr. Gamma-UO_3 was prepared by calcining previously calcined uranyl nitrate hexahydrate at 550°C for 4 hr in air. It was established by chemical analysis that the oxides obtained had the following composition: amorphous $UO_3 - UO_{3.01\pm0.01}$, α-$UO_3 - UO_{2.99\pm0.01}$, β-$UO_3 - UO_{3.02\pm0.01}$, and γ-$UO_3 - UO_{3.01\pm0.01}$. Thermal, kinetic, and x-ray analysis made it possible to understand the phase relations in the dissociation of amorphous UO_3. The temperatures at the start of dissociation for alpha-UO_3, beta-UO_3, and gamma-UO_3, determined by a kinetic method, are respectively, 460, 430, and 510°C. Curves for the heating of polymorphous UO_3 in a vacuum show that the dissociation process of alpha-UO_3 proceeds at 575 to 613°C, beta-UO_3 at 525 to 570°C, and gamma-UO_3 at 610 to 660°C. The final product of the dissociation of all forms of UO_3 is the U_3O_8 phase. The divergences in the temperatures for the start of dissociation, determined from thermographic and kinetic investigations, are connected with the special characteristics of the methods. The data indicated that the thermal stability of polymorphic UO_3 increases in the following order: amorphous UO_3, beta-UO_3, alpha-UO_3, and gamma-UO_3. (ATD)

26902 PREPARATION OF HYDRIDES OF TRANSITION METALS OF THE FOURTH AND FIFTH GROUP OF THE PERIODIC SYSTEM. Antonova, M. M.; Samsonov, G. V. Zh. Prikl. Khim., 38: 2393-7(Nov. 1965). (In Russian).

Reactions of powdered titanium, zirconium, niobium, vanadium, and tantalum with hydrogen were studied to optimize the operating conditions (temperature and time) for preparing the richest hydrides of these metals. The study was prompted by expansion of potential technological uses of transition metal hydrides. The vacuum apparatus, starting materials, operating procedure, and analytical method of hydrogen determination in hydrides are described. The experimental data were tabulated for titanium and zirconium powders and tantalum shavings. Corresponding data for niobium and vanadium were given previously. The optimum temperature and time of the reactions are given for preparation of $TiH_{1.93}$, ZrH_2, $VH_{0.915}$, NbH, and $TaH_{0.69}$. These compositions, with the exception of NbH, contain the maximum absorbable hydrogen. The maximum absorbable hydrogen content in niobium is 63 at.%, which corresponds to NbH_2, but this phase was not detected in the product. The formation of hydrides was correlated with electron transfer from hydrogen to unfilled d-electron shells of the transition metal, and the hydrogen absorption was correlated with the acceptor capability of these shells. (ATD)

26903 SYNTHESIS AND REACTIONS OF SULFUR AND SELENIUM COMPOUNDS. Mautner, Henry G. (Yale Univ. School of Medicine, New Haven). pp 409-21 of CONF-651111.

Recent progress in the synthesis of selenium isologues of sulfur compounds of biological significance is reviewed. Differences of the relative nucleophilicities and the leaving tendencies of selenomercaptide and mercaptide ions are discussed in terms of electronic configuration. Studies of the relative hydrolysis and aminolysis rates of selenol esters, thiol esters, and esters as well as the susceptibilities of these compounds to neighboring group interactions are discussed. Work dealing with the relative ease of oxidation of thiols and selenols and the relative ease of reduction of disulfides and diselenides is reviewed. (auth)

26904 SPECTROSCOPIC STUDY OF CERIUM IN YTTRIUM GALLIUM AND YTTRIUM IRON GARNET. Wickersheim, K. A. (Lockheed Missiles and Space Co., Palo Alto, Calif.); Buchanan, R. A. 12p. (CONF-650804–19). ORINS. Gmelin, AED-CONF-65-208-3.

From 5th Rare Earth Research Conference, Ames, Iowa.

A fundamental problem in magnetism is the origin and description of the exchange interaction between magnetic ions. The development of an exchange field formalism, applicable to the rare earth ions in the rare earth ion garnets, is reviewed. It is shown that further progress depends upon a more complete solution of the crystal field problem and on the acquisition of more experimental exchange splittings for specific rare earth ions. The advantages of using cerium as a "probe" to provide necessary information are discussed. Cerium and ytterbium are compared, and spectroscopic results for cerium substituted into both yttrium gallium and yttrium iron garnet are presented. The large size of the crystal field splittings (of the order of 1500 cm^{-1} for the $J = 7/2$ state), the large size of the exchange splittings of Kramer's doublets (of the order of 200 cm^{-1}), and the general sharpness of the cerium spectra are considered. (auth)

26905 CHEMISTRY SESSION C. BOOK THREE [OF PREPRINTS OF] FIFTH RARE EARTH RESEARCH CONFERENCE, AUGUST 30-SEPTEMBER 1, 1965. 141p. (CONF-650804(Bk.3)). ORAU.

Thirteen papers presented at the chemistry session of the Fifth Rare Earth Research Conference are collected. Separate abstracts were prepared for 8 papers and the remaining 5 were previously abstracted for NSA. For abstract numbers of individual papers see CONF-650804 in the Report Number Index. (M.C.G.)

For abstracts of individual papers see: 26906–26912 and 27046.

26906 CRYSTAL CHEMISTRY OF THE SULFIDES, SELENIDES AND TELLURIDES OF THE RARE EARTHS AND YTTRIUM. Flahaut, Jean (Inorganic Chemistry Lab., Faculty of Pharmacy, Paris). pp 1-12 of Chemistry Session C. Book Three [of Preprints of] Fifth Rare Earth Research Conference, Aug. 30-Sept. 1, 1965.

Observed phases in the L_2X_3 compounds of rare earths with sulfur, selenium, and tellurium are reviewed. The crystal structures of L_5S_7 compounds, rhombohedral L_3Se_4 compounds, tetragonal LTe_2 compounds and pseudo-tetragonal LTe_3 compounds, $L_2O_2S_2$ and $L_2O_2Se_2$ com-

pounds, and LSI compounds are described. Intermediate compounds between rare earth sulfides or selenides (L_2X_3) and MX sulfides or selenides were also studied. (29 references). (M.C.G.)

26907 ON THE MONOXIDE OF SAMARIUM. Felmlee, Theron L.; Eyring, LeRoy (Arizona State Univ., Tempe). pp 13-24 of Chemistry Session C. Book Three [of Preprints of] Fifth Rare Earth Research Conference, Aug. 30-Sept. 1, 1965.

A method for preparing samarium monoxide with the NaCl-type structure was developed. Compounds were prepared with two different colors: a deep red preparation with a lattice parameter $a_0 = 4.988 \pm 0.002$ Å, and a gold colored product with $a_0 = 4.9784 \pm 0.0005$. The gross composition of the compounds was established as SmO. These results were compared with previous reports. Trends in the behavior of rare earth chalcogenides, which give the anomalously low lattice parameter for SmO, are discussed. (auth)

26908 MIXED CRYSTAL PHASES WITH PRASEODYMIUM DIOXIDE. Brauer, Georg; Pfeiffer, Burkhard (Univ., Freiburg i. B.). pp 25-35 of Chemistry Session C. Book Three [of Preprints of] Fifth Rare Earth Research Conference, Aug. 30-Sept. 1, 1965.

Praseodymium oxide was combined with the sesquioxides of La, Nd, Sm, Gd, Dy, and Er. The oxide mixtures with graduated compositions were heated in pure oxygen at 10 atm at about 400°C to give mixed crystals. It was found that the praseodymium has a high valency near PrO_2 and that extended mixed crystal series occur with a defect lattice closely related to the fluorite-type structure. The way in which oxygen dissociation pressure depends on the composition of the ternary oxide phases is discussed. (auth)

26909 CRYSTAL STRUCTURE OF THE RHOMBOHEDRAL $MO_3 \cdot 3R_2O_3$ COMPOUNDS (M = U, W AND Mo) AND THEIR RELATION TO ORDERED R_7O_{12} PHASES. Bartram, S. F. (General Electric Co., Cincinnati). pp 43-54 of Chemistry Session C. Book Three [of Preprints of] Fifth Rare Earth Research Conference, Aug. 30-Sept. 1, 1965.

A complete three-dimensional structure analysis of the mixed oxide $UO_3 \cdot 3Y_2O_3$ was carried out using single-crystal data. This structure is characteristic of a large family of rhombohedral compounds containing rare earth oxides and having an oxygen-to-metal ratio of 12:7. Bond lengths and coordination polyhedra for the atoms in the rhombohedral structure were compared with those in other known oxides. The relation between $U_mY_{7-m}O_{12}$ compositions ($1 < m < 2.0$) and ordered $RO_{1.71}$ phases is shown. Some conclusions are drawn as to their mode of oxidation. (auth)

26910 THE SUCCESSIVE STABILITIES OF THE RARE EARTH 1-HYDROXYCYCLOPENTANE CARBOXYLIC ACID CHELATES. Powell, J. E.; Rowlands, D. L. G. (Ames Lab., Ames, Iowa). pp 67-77 of Chemistry Session C. Book Three [of Preprints of] Fifth Rare Earth Research Conference, Aug. 30-Sept. 1, 1965.

The formation constants of the first three chelate species of tripositive rare earth cations with the 1-hydroxycyclopentanecarboxylic (HCPC) acid ligand were determined. Some values of b_4 are also reported. Measurement was by a potentiometric method at 25°C, and the ionic medium was maintained at $\mu = 0.1$ by the supporting electrolyte, sodium perchlorate. Ionization constants of the acid were also determined over the same ligand range. From the stability constant ratios, and hydration data on solid species, obtained using a thermobalance technique, an effort was made to postulate the coordination number in the complex and the dentate character of the ligand, based on the nine-coordinate, trigonal prism +3 model. (auth)

26911 PREPARATION OF THE CARBONATES OF THE RARE EARTHS FROM SOME OF THEIR ORGANIC ACID SALTS. Head, E. L. (Univ. of California, Los Alamos, N. Mex.). pp 99-105 of Chemistry Session C. Book Three [of Preprints of] Fifth Rare Earth Research Conference, Aug. 30-Sept. 1, 1965. (LA-DC-7033; LA-DC-7033(Rev.)).

A method that permits preparation of the sesquicarbonates of all of the rare earths and yttrium from certain organic acid salts of the rare earths is described. Specifically, application of CO_2 pressure to aqueous solutions of the formates, acetates, propionates, and butyrates produces the rare earth cabonates. Although this method produces the normal carbonates at 23°C, the application of heat increases the yield and filterability of the product. The composition and yields of the products prepared from acetates and propionates are given; the yields ranged generally in the vicinity of 50 to 60%. Impurities due to the organic acid group may range from virtually zero to 1 or 2 wt %. In addition to the hydrates normally reported for the carbonates, the heptahydrate of Er, the penta- to hexahydrate of Yb, and the hexahydrate of Lu were prepared. X-ray powder patterns are obtained of all of the carbonates prepared from the propionates. (auth)

26912 A SOLUTION CALORIMETER WITH AUTOMATIC ADIABATIC CONTROL DESIGNED FOR RARE EARTH RESEARCH. Stubblefield, C. T. (Prairie View A. and M. College, Texas). pp 129-40 of Chemistry Session C. Book Three [of Preprints of] Fifth Rare Earth Research Conference, Aug. 30-Sept. 1, 1965.

The thermochemistry of the rare earths requires a calorimeter with low heat capacity and extremely close adiabatic control since the heat liberated is often small and the reaction slow. These facts were considered in the design of a solution calorimeter. The associate control circuits for obtaining adiabatic conditions and the accompanying measuring circuits for temperature and heat equivalents may be used with either one of two unitized calorimeter assemblies. The smaller assembly accommodates a rare earth salt weighing about 0.1 gram reacting in about 28 ml of acid or water; and the larger one can handle 1 gram samples in nearly 300 ml of water or acid. Each tantalum calorimeter is concentric with a copper adiabatic shield and an outer brass isothermal shield. The assembly to be used is operated in a 30 gallon water bath, controlled at 23.00°C. The temperatures of the adiabatic shield is controlled both manually and automatically by nichrome heaters wrapped on the outside. Any difference between this temperature and that of the calorimeter is detected by a thermopile, and the output voltage of the thermal is observed on a meter after amplification. The amplified output also automatically controls the temperature of the adiabatic shield by programming a d-c power supply. The temperature of either calorimeter is measured with a platinum resistance thermometer affixed around the interior of its adiabatic shield. The heat capacities of the calorimeters are determined electrically. The heats of formation of $EuCl_2$(s) and of the aqueous Eu^{2+} ion were determined in the larger unit. (auth)

Organic Chemistry

Refer also to abstracts 26706 and 26903.

26913 GAS-LIQUID PARTITION CHROMATOGRAPHY OF PERDEUTERIOETHANE. ISOTOPE EFFECTS ON VAPORIZATION FROM SOLUTION. Van Hook, W. Alexander; Phillips, James T. (Univ. of Tennessee, Knoxville). J. Phys. Chem., 70: 1515-20(May 1966).

Gas-liquid chromatographic separation factors for the system $C_2H_6-C_2D_6$ were obtained over the temperature range from 0 to −130°C on a variety of liquid partition columns. The isotope effects were pronounced functions of the temperature. The logarithm of the separation factors varied by more than a factor of 3 when the substrate was changed from highly polar (such as CH_3CHO) to nonpolar (such as 2,3,4-trimethylpentane) liquids. These results and some earlier results of Liberti, Cartoni, and Bruner on the system $C_6H_6-C_6D_6$ were interpreted with the aid of the statistical theory of isotope effects in condensed systems and consistency with the theory is demonstrated. (auth)

26914 INTRAMOLECULAR KINETIC CARBON ISOTOPE EFFECT IN THE GAS PHASE DECOMPOSITION OF DEUTERIOOXALIC ACID. Lapidus, Gabriel; Barton, Donald; Yankwich, Peter E. (Univ. of Illinois, Urbana). J. Phys. Chem., 70: 1575-8(May 1966). (COO-1142-64).

The intramolecular ^{13}C kinetic isotope effect was measured between 127 and 180°C in the decomposition to carbon dioxide and formic acid of oxalic acid-d_2 vapor at an initial pressure of 0.8 mm. This isotope effect was small, 0.5% maximum, but had a temperature dependence so large that it inverted within the experimental range. It is shown that ordinary isotope effect theory and assumptions of low pressure effects, such as described by Rabinovitch and his co-workers, are inadequate to explain the results or would not come into play, respectively. It is postulated that multiple reaction paths are responsible for the phenomena observed. (auth)

26915 NEW METHODS OF SYNTHESIZING ^{14}C-LABELLED AMINO ACIDS. I. SYNTHESIS OF DL-ALANINE-1-^{14}C. Egyed, J.; Meisel, T. Magyar Tud. Akad. Kozp. Kem. Kut. Int. Kozlem., 8: 29-33(1964).

Ethyl N-(1-phthalimidoethyl)-carbamate (0.005 mole) and $K^{14}CN$ (0.3228 g) are refluxed in ethanol (10 ml) for 1.5 hr. The reaction mixture is cooled, and the crystals are removed by filtration. The filtrate is treated with concentrated hydrochloric acid and refluxed for 2 hours. Evaporation of the yellow solution gives a viscous oil. Chromatography over Dowex 50 resin yields N-carbethoxyalanine-1-^{14}C as the main product. Hydrolysis of this compound is accomplished in 3:1 hydrochloric acid–glacial acetic acid mixture by treatment for 12 hours. The product is evaporated to dryness, dissolved in water, and purified by chromatography. The activity of the produced alanine-1-^{14}C was 0.081 mC/mmole. A yield of 69.2%, calculated for $K^{14}CN$, was obtained. (Hung. Tech. Abstr.)

26916 NEW METHODS OF SYNTHESIZING ^{14}C-LABELLED AMINO ACIDS. II. SYNTHESIS OF DL-VALINE-^{14}C AND DL-β-PHENYLALANINE-1-^{14}C. Egyed, J.; Meisel, T. Magyar Tud. Akad. Kozp. Kem. Kut. Int. Kozlem., 8: 35-8(1964).

Ethyl N-(1-phthalimido-2-methylpropyl)-carbamate (0.005 mole) or ethyl N-(1-phthalimido-2-phenylethyl)-carbamate (0.006 mole) is refluxed with $K^{14}CN$ in anhydrous ethanol for 1.5 hr. Potassium phthalimide is removed by filtration and the filtrate boiled with concentrated hydrochloric acid for two hours. The reaction mixture is evaporated to dryness. When synthesizing DL-valine-1-^{14}C, the residue is boiled with a mixture of hydrochloric acid and acetic acid (3:1) and allowed to stand in a refrigerator. Phthalic acid is filtered off, the filtrate evaporated, dissolved in water and deionized over a column of Dowex 50 resin. The yield, based on $K^{14}CN$, was 52%. In the synthesis of DL-β-phenylalanine-1-^{14}C the hydrochloride is dissolved in water and the pH adjusted to 5.9 with concentrated ammonium hydroxide. The precipitate is filtered off to give the product with a yield of 43.5%. (Hung. Tech. Abstr.)

26917 INFRARED SPECTROSCOPY STUDIES OF REACTIONS BETWEEN ALCOHOLS AND PRODUCTS OF ALCOHOL DECOMPOSITION WITH YTTRIUM OXIDES. Krasil'nikova, M. K.; Lygin, V. I.; Topchieva, K. V. (Moscow State Univ.). Teor. Eksp. Khim., 2: 89-96 (Jan.-Feb. 1966). (In Russian).

The adsorption of methyl and ethyl alcohols, acetaldehyde, ethylene, and water on two samples of yttrium oxide was investigated by infrared spectroscopy. One of the samples had a dehydrating property and the other a dehydrogenating property. The existence of different surface compounds in the dehydration and in the dehydrogenation reactions of the alcohols was shown. The possible decomposition mechanisms were discussed. (tr-auth)

26918 VIBRATIONAL SPECTROSCOPIC INVESTIGATIONS ON ^{10}B-SUBSTITUTED DIALKYL AMINOBORANES. Becher, H. J.; Baechle, H. T. (Technische Hochschule, Stuttgart). Z. Phys. Chem. (Frankfurt), 48: 359-78(Mar. 1966). (In German).

The aminoboranes $Cl_2BN(CH_3)_2$, $Cl_2BN(C_2H_5)_2$, $ClB[N(CH_3)_2]_2$, $ClB[N(C_2H_5)_2]_2$, $B[N(CH_3)_2]_3$, and $B[N(C_2H_5)_2]_3$ was prepared with 92 or 96% ^{10}B enrichment and their oscillation spectra were investigated by Raman and infrared spectroscopy. The frequency differences between the aminoboranes containing ^{11}B and ^{10}B permit, with the help of force-constants calculations, a completion of earlier arrangements and improved assumptions on the oscillation character of the frequencies observed. Between DN and NC oscillations, coupling relations were established, which led to a mixture of the internal coordinates in the individual oscillation forms. In this coupling a δ-CH_3 was incorporated in the dimethylaminoboranes and a γ-CH_2 in the diethylaminoboranes, and these also depended on the particular boron isotope. The spectrum of $Cl_2BN(C_2H_5)_2$ indicated, by supplementary frequencies, a rotation isomerism that can be traced back to the different angles of the ethyl groups relative to the Cl_2BN groups. (tr-auth)

Radiation Chemistry

See also BIOLOGY AND MEDICINE — Radiation Effects on Biochemicals Radiation Effects on Tissues

26919 (AD-632666) X IRRADIATION OF NORMAL SATURATED HYDROCARBONS. Albrecht, T. W.; Cheever, P. R. (General Dynamics/Fort Worth, Tex.). Apr. 13, 1966. Contract AF29(601)-6643. 31p. (AFWL-TR-66-3; FZK-272). CFSTI $2.00 cy, $0.50 mn.

The development of trans-vinylene in x-irradiated octacosane and Marlex 6002 polyethylene films was measured by means of the infrared spectrometer. Initial development of the trans-vinylene in the octacosane films at temperatures of 137, 229, and 289°K had a G-value of 2.1 ± 0.4 bonds formed per 100 ev, with decay of the trans-vinylene being most rapid at the highest temperature. Hydrogen evolution from x-irradiated films of these same materials was measured by means of the mass spectrometer. The evolution showed a decrease as the temperature of the irradiation was decreased below 194.5°K, with practically no hydrogen liberation at liquid-nitrogen temperature. When the cold irradiated films were slowly warmed, they released a burst of hydrogen at approximately 194.5°K. The amount of hydrogen liberated in the burst was dependent upon the irradiation temperature and the irradiating time. EPR spectra of the free radicals in irradiated Marlex 6002 polyethylene were predominantly of seven lines centered at g = 2.003 and spanning 120 gauss. (auth)

26920 (AECL-2562) THE USE OF AMMONIA TO SUPPRESS OXYGEN PRODUCTION AND CORROSION IN BOILING-WATER REACTORS. Le Surf, J. E.; Bryant, P. E. C.; Tanner, M. C. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Apr. 1966. 12p. (CONF-660415-1). Dep. mn. AECL $0.50.

From 22nd Annual Conference of the National Assn. of Corrosion Engineers, Miami Beach, Fla.

Radiolysis of the coolant in nuclear reactors cooled by boiling water results in oxygen in the steam and recirculated water phases. This has dictated the use of stainless steels as the major circuit materials for these reactors. It is shown that ammonia additions to the coolant eliminate oxygen production, permitting the use of mild steel for circuit construction with consequent savings in capital cost. Corrosion data are presented for various out-reactor materials (carbon steel, low alloy steels, stainless steels, Monel alloy 400, Inconel alloy 600) exposed to the coolant of two phase in-reactor loops when operated neutral and with ammonia addition. The elevation in pH resulting from ammonia addition is a further advantage for low temperature parts of the circuit. (auth)

26921 (BNL-10208) INVESTIGATIONS AND APPLICATIONS OF THE CHEMICAL EFFECTS OF NUCLEAR TRANSFORMATIONS. II. THE SZILARD-CHALMERS PROCESS IN METALLOPHTHALOCYANINES. Hillman, Manny; Weiss, Allen J. (Brookhaven National Lab., Upton, N. Y.). May 11, 1966. Contract AT(30-2)-Gen-16. 19p. (CONF-660503-2). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From 7th Japanese Conference on Radioisotopes, Tokyo.

Investigations on the Szilard-Chalmers process in Zr and Hf phthalocyanine are described. Irradiations were carried out for 10 min in a pneumatic tube facility at fluxes approximately 10^{13} n cm^{-2} sec^{-1}. Separation of recoil atoms from parent compounds was accomplished by dissolution of the metallophthalocyanine in DMSO followed by reprecipitation by filtration through 0.45 μm Millipore filter paper. Enrichment factors and retentions for the individual isotopes was accomplished by means of gamma spectrometry. Isotope effects observed in the reactions are discussed. (P.C.H.)

26922 (BNWL-SA-591) THE RADIOLYSIS OF A MIXTURE OF CARBON DIOXIDE AND HYDROGEN. Tingey, G. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1966. Contract AT (45-1)-1830. 17p. (CONF-660409-2). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From Libby/Cockcroft Meeting on Graphite Chemistry, Harwell, Eng.

The γ radiolysis of CO_2 and H_2 was investigated. Initially, CO and H_2O vapor were formed in equal quantities along with small quantities of CH_4. As the reaction progressed the rate of CO formation decreased rapidly with a much smaller decrease in the rate of H_2O formation. An orange solid, with empirical formula $C_2H_3O_{1.1}$, was also formed in the reaction. The yield of CO and H_2O, over the temperature range from 100 to 400°C, is given by $G(CO) = G(H_2O) = 17.3\ e^{-1,700/RT}$ molecules/100 ev. The yield of CH_4 was 0.3 molecules/100 ev at 100°C and decreased as the temperature increased. Variations in relative concentrations of the reactants showed that the activated species from H_2 (H_2^+ or H) contribute only to methane formation with little or no effect on the formation of CO and H_2O. (auth)

26923 (COO-1528-5) RADIOLYSIS STUDIES ON FLUOROCARBONS AND ON REACTIVE INTERMEDIATES. Technical Progress Report, September 1, 1965–August 31, 1966. Kevan, Larry (Kansas Univ., Lawrence. Dept. of Chemistry). May 16, 1966. Contract AT(11-1)-1528. 30p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

The results of studies on paramagnetic relaxation of trapped electrons in alkaline ices and fluorocarbon radiolysis are reported. A brief abstract on electron and excited water reactions in nitrate ices is also included. Results in aqueous and in frozen solutions showed very close parallels and strongly implied that the same radioinduced intermediates are formed and react similarly in both phases. Studies on NaOH showed that the F-center model of the electron trapped in a hydroxyl ion vacancy remains consistent with the relaxation studies although the particular spin-lattice relaxation mechanisms of electrons in KCl and in ice differed. The dominant spin-lattice relaxation mechanism for the electron in ice probably involves cross relaxation with an O^- radical ion. It was concluded that spin-spin interactions take place between spins within a spur and therefore that the anion vacancy is located within a spur in the irradiated ice from radiolysis studies on C_2F_6, C_3F_8, and C_4F_{10}, it was concluded that the predominance of C–C bond breaking over C–F bond breaking is a general characteristic of perfluoroalkane radiolysis. The most probable excitation energy for radiolytic intermediate in nonpolar systems is believed to be between 20 and 35 kcal. (P.C.H.)

26924 (MIT-334-48) IN-PILE LOOP IRRADIATION STUDIES OF ORGANIC COOLANT MATERIALS. Progress Report, October 1–December 31, 1965. Morgan, D. T.; Bley, W. N. (Massachusetts Inst. of Tech., Cambridge. Dept. of Nuclear Engineering). Apr. 1, 1966. Contract AT(38-1)-334. 32p. (MITNE-75). Dep. mn. CFSTI $2.00 cy, $0.50 mn.

Transient Run 15 which degraded the terphenyl from the 83% level of Steady-State Run 14 to the level of 61% desired for Steady-State Run 16 was completed. The irradiation temperature for this run was 800°F to minimize the time required to change concentrations between Runs 14 and 16. The analysis of data from Transient Run 15 was complicated by the occurrence of radiopyrolysis at the irradiation temperature of 800°F as well as the change of reactor power levels which took place during this run. Using the results of steady-state Run 14 along with the results of Run 15, the radiolysis rate constant, $k_{R,2}$ (second order), and the radiopyrolysis rate constant, k_p, were estimated to be 2.33×10^{-2} and 1.1×10^{-3} hr^{-1}, respectively. The degradation results from Run 14 were compared and analyzed with those of others in order to investigate the reaction order and the fast neutron effect ratio G_N/G_γ. The value of G_N/G_γ and the reaction rate order which fits the M.I.T. data as well as that of most other investigators appears to be about 4.7 and second order, respectively. Considerable progress was made in improving the precision and reproducibility of the terphenyl analysis. It is now felt that the terphenyl content of a single sample can be determined to about an accuracy of ±0.5% (one standard deviation). In order to better define the fast neutron spectrum in the organic material, new foil materials are being evaluated for use at M.I.T. to fill in the energy gap from 120 ev (^{59}Co resonance) to 2.9 Mev (Ni threshold) where measurements are not now made. ^{238}U, ^{236}U, and ^{234}U were selected as new threshold detectors with threshold energies of 1.3, 0.84, and 0.24 Mev, respectively; ^{23}Na was selected as a new resonance detector with a resonance energy of 2.9 kev. In order to increase the accuracy of the calorimetric measurements, particularly the fast neutron dose rate, special low A materials which will have high fast neutron dose rates were evaluated and LiH selected as a new calorimeter material to supplement those now used. Irradiated organic samples from Run 14 were analyzed by Atomics International for water MST, and oxygen content, and the values were found to be similar to those for the PNPF coolant. (P.C.H.)

26925 (NP-16037) PARAMAGNETIC CENTERS FORMED BY IRRADIATION IN THE OXYGENATED COMPOUNDS OF SELENIUM. II. E. S. R. SPECTRA OF POLYCRYSTALLINE IRRADIATED $SeO_4(NH_4)_2$. Constantinescu, M.; Constantinescu, O.; Pascaru, I.; Gird, E. (Institutul de Fizica Atomica, Academia R. P. R., Bucharest (Romania)). Dec. 21, 1965. 16p. Dep. mn.

The effects of gamma and neutron irradiation on polycrystalline $SeO_4(NH_4)_2$ were studied by ESR and radiochemical methods. From the ESR spectra and from the behavior on heating, NH_3^+ and O_2^- radicals as well as radicals from selenium which can be of SeO_4^-, SeO_3^- or SeO_2^- type, were observed. A mechanism of formation for these species is suggested. The dependence of paramagnetic center concentration on the integral dose was also studied. (auth)

26926 CHEMONUCLEAR AND RADIATION CHEMICAL PROCESS DEVELOPMENT PROGRAM AT BROOKHAVEN NATIONAL LABORATORY. Steinberg, Meyer; Manowitz, Bernard (Brookhaven National Lab., Upton, N. Y.). pp 89-110 of Application of Large Radiation Sources in Industry. The Hague, Nederlands Atoomforum, [1965].

The development of an economically feasible program for the production of chemicals by radioinduced reactions is discussed. The chemonuclear processing phase deals with utilizing fission fragment and neutron and gamma energy in nuclear reactors for the synthesis and production of chemicals. These studies include: an experimental program for the determination of the fission fragment energy deposition efficiency of various thin sectioned fuel elements, and the evaluation of G values in static capsule tests for certain chemical reactions, such as the formation of NO_2 from N_2 and O_2, and CO from CO_2; development and fabrication of fission fragment sources and fuel elements; the design and construction of a chemonuclear in-pile loop facility; and the design and evaluation of various chemonuclear reactor and process concepts. The radiation chemical process development program involves the following: an extensive investigation of the homopolymerization of ethylene by ^{60}Co gamma radiation; a survey program on the copolymerization of ethylene with a number of other monomers; a survey program of a number of promising exothermic systems induced by ^{60}Co gamma radiation; and the development of fundamentals and demonstration of the technology of isotope radiation engineering applied to chemical processing. Thus far, the results of this program are promising. (J.G.B.)

26927 EXPERIMENTAL DEVICE FOR STUDYING PROCESSES OF CHEMONUCLEAR SYNTHESIS. Brazh-

nikov, E. M.; Dzantiev, B. G.; Popov, V. N.; Russiyan, E. K.; Shalomeev, A. S. At. Energ. (USSR), 20: 279-81 (Mar. 1966). (In Russian).

A device for studying chemonuclear synthesis in the gaseous phase is described. The device consists of a vertical channel coupled to a reactor channel and a set of circulating and analyzing auxiliaries. (G.O.Y.)

26928 PULSE RADIOLYTIC INVESTIGATIONS OF THE RADICAL ANIONS SO_4^-. Heckel, E.; Henglein, A.; Beck, G. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Ber. Bunsenges. Physik. Chem., 70: 149-54 (Mar. 1966). (In German).

OH radicals from the radiolysis of water react with HSO_4^- ions to form the radical anion SO_4^-. This particle has maximum extinction (1.05×10^3 mole^{-1} liter cm^{-1}) at 4500 Å. The rate constant of OH + HSO_4^- amounts to 8×10^5 mole^{-1} liter sec^{-1}. In the presence of reducing compounds, the extinction at 4500 Å is decreased, since some of the OH radicals are scavenged. The process OH + HSO_4^- may therefore be used as standard reaction for the determination of rate constants of reactions between OH radicals and various substances. $k_{Fe^{2+}+OH}$ was found to be equal to 5.0×10^9 mole^{-1} liter sec^{-1}. Reactions of the SO_4^- ion with added substances were also observed: $k_{Fe^{2+}+SO_4^-} = 9.9 \times 10^8$ mole^{-1} liter sec^{-1}, $k_{CH_3OH+SO_4^-} = 2 \times 10^7$, and $k_{C_2H_5OH+SO_4^-} = 3 \times 10^7$ mole^{-1} liter sec^{-1}. (auth)

26929 RADIOCHEMICAL DETECTION OF DEFECT ELECTRON MIGRATION IN IRRADIATION OF SILVER HALIDES. Lieser, K. H.; Lakatos, E.; Hoffmann, P. (Techniche Hochschule, Darmstadt, Ger.). Ber. Bunsenges. Physik. Chem., 70: 176-80(Mar. 1966). (In German).

Pellets pressed from purest silver iodide were labeled on one side by isotope exchange using ^{131}I. Irradiation of the nonlabeled side with uv light set free ^{131}I from the labeled side, which was away from the light. This was measured in a stream of methane using a proportional flow counter, and also by absorption in 1N sodium hydroxide and measurement in a scintillation counter. The quantum yield was about 3×10^{-6}. Measurements could be reproduced within experimental error. The number of incident light quanta was varied by varying the time of irradiation; in this way proportionality between the number of iodine atoms liberated and the time of irradiation was established. (auth)

26930 YIELD OF REDUCING RADICALS IN RADIATION OXIDATION OF CHROMITE(III) IN ALKALINE SOLUTIONS. Kalecinski, J. (Institute of Structural Research, Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Chim., 14: 137-41(1966).

The effects of gamma radiation on the redox system CrO_4^{2-}–CrO_2^- in alkaline solutions were studied. Yields of chromite(III) to chromate(VI) ions are reported. The concentration of the chromate formed in deaerated solutions of potassium chromite was a linear function of dose; accordingly, the oxidation yield of chromite ions, $G(CrO_2^-)$, was calculated from the slope of the straight line as 0.155 ± 0.015 ions/100 ev. Application of the steady-state theory to the reaction, which enables the primary yield of reducing radicals to be calculated, is described. The alkaline chromite solutions saturated with air undergo oxidation to chromate by the chromate formed is not a linear function of dose. Hence, the yield of oxidation of the chromite decreased with increasing dose. (F.J.H.)

26931 A KINETIC STUDY OF THE γ-RADIATION-INDUCED POLYMERIZATION OF ETHYLENE AT A NORMAL TEMPERATURE. Machi, Sueo; Hagiwara, Miyuki; Gotoda, Masao; Kagiya, Tsutomu (Japan Atomic Energy Research Inst., Gunma). Bull. Chem. Soc. Jap., 39: 675-80(Apr. 1966).

The γ-radioinduced polymerization of ethylene was carried out in the intermediate pressure region from 70 to 400 kg/cm^2 with a dose rate from 5×10^3 to 4.3×10^5 rad/hr and at a temperature of 30°C. An overall G-value of the 10^4 order was usually obtained. No induction period for polymerization was observed. The polymerization rate and the molecular weight of the polymer formed increased almost proportionally with the reaction time and with the pressure of ethylene. The dose-rate exponents of the rate and the molecular weight were found to be 0.9 and 0, respectively. These results indicated that the stationary-state hypothesis, i.e., that the rate of initiation is equal to that of termination, is not realized in this polymerization. From kinetic discussions of the initial stage of polymerization, where the concentration of the monomer remains essentially constant, it was concluded that the rates of termination and transfer reaction are very small; the life of the polymer radicals is, therefore, quite long and the growing of polymer radicals proceeds successively under irradiation. (auth)

26932 REACTIONS OF HYDROGEN ATOMS WITH METHYLAMINE INITIATED BY IONIZING RADIATION. Takamuku, Setsuo; Sakurai, Hiroshi (Osaka Univ.). Bull. Chem. Soc. Jap., 39: 841-3(Apr. 1966).

The radiolysis of methylamine with and without ethylene was investigated at various temperatures up to 152°C. The relative importance of the radical process (80%) in hydrogen formation was independent of the temperature, though there were slight decreases in total hydrogen formation at high temperatures. The thermal hydrogen atoms formed in the primary process may be supposed to abstract mainly the N–H hydrogen atoms of methylamine, because the activation energy for the process was observed to be 4.2 kcal/mol, much lower than any C–H type abstraction. (auth)

26933 CHARGE TRANSFER IN THE RADIOLYSIS OF BINARY HYDROCARBON MIXTURES. Stone, J. A.; Quirt, A. R.; Miller, O. A. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Chem., 44: 1175-82 (May 15, 1966). (AECL-2414).

The radiolysis of dilute solutions of ethane-d_6, propane-d_8, and n-butane-d_{10} in liquid hydrocarbons at 195°K resulted in the production of D_2 and HD in amounts determined by the relative ionization potentials of solvent and solute. Solvents of higher ionization potential enhanced the production of D_2 and HD from deuterated solutes of lower ionization potential. When the ionization potentials were in the reverse order the yields were diminished. This solute–solvent interaction, which is ionic in nature, is a general phenomenon in the radiolysis of mixtures of saturated hydrocarbons in the liquid phase and is consistent with charge transfer between solvent and solute. (auth)

26934 FORMATION OF EXCITED ETHANE IN THE TRITIUM RECOIL LABELLING REACTION. Johnston, A. J.; Malcolme-Lawes, D.; Urch, D. S.; Welch, M. J. (Queen Mary Coll., London). Chem. Commun., No. 7, 187-8(Apr. 13, 1966).

The reaction of recoil tritium atoms with ethane was previously studied in the presence of bromine scavenger using different pressures of bromine, ethane, and tritium. In all cases the total neutron dose was $(1.05 \pm 0.05) \times 10^{15}$ n cm^{-2} and analyses were delayed until the bromine activity was negligible. A comparison of tubes with similar ethane pressures showed that R is insensitive to changes in bromine pressure. The results showed that CH_2TBr and C_2H_5T are both formed from tritium atoms of similar energies. All the observations were consistent with $CH_2T\cdot$ radicals being formed from the unimolecular decomposition of excited C_2H_5T. It was concluded that 65% of the labeled ethane molecules do not have the excitation energy ever to undergo a unimolecular decomposition. Following Marcus and assuming the bimolecular rate constant to be Zλ, and taking Z to be 5×10^7 cm^{-1} sec^{-1}, then $k_l = 2.17 \times 10^{10}\ \lambda$ sec^{-1}, which corresponds to an average half life for excited C_2H_5T of 32 μμ sec and E (energy of excitation) ~5 ev if λ (the efficiency of the deactivating collision) = +1. (F.J.H.)

26935 OLEFINS AS TRIPLET-STATE SCAVENGERS IN IRRADIATED SYSTEMS. Cundall, R. G. (Univ., Nottingham, Eng.); Griffiths, P. A. Chem. Commun., No. 7, 194-5(Apr. 13, 1966).

The use of olefins as triplet-state scavengers in irradiated systems is discussed. An investigation was made of the irradiation of benzene solutions of biacetyl or anthracene with 2 μsec pulses of 4-Mev electrons. The addition of cyclohexene caused a reduction in the triplet

yields of both solutions. In a 3.7×10^{-2}M solution of biacetyl there was a decrease of 44% in the intensity of biacetyl phosphorescence at 520 mμ in a 5×10^{-1}M-cyclohexene solution. Anthracene triplet absorption spectra at 424 mμ observed in a 2×10^{-2}M anthracene solution showed a decrease of 40% in a 5.0×10^{-1}M cyclohexene solution. The ability of the olefin to remove triplet states as shown in the experiments may be used in both photochemical and high-energy-irradiated systems. (F.J.H.)

26936 TRIPLET PARTICIPATION IN THE RADIOLYTIC TYPE II CLEAVAGE OF n-BUTYROPHENONE. Brown, Weldon G. (Argonne National Lab., Ill.). Chem. Commun., No. 7, 195-7(Apr. 13, 1966).

Gamma and ultraviolet radiolysis of butyrophenone and the effects of anthracene and naphthalene on the triplet-state products are discussed. The identification and analysis of 1-phenylcyclobutanol in irradiated specimens were based on the gas chromatographic separation of the mixtures at 175°C. In the photolysis of a 0.007M solution of n-butyrophenone to less than 10% conversion, the yield of 1-phenylcyclobutanol relative to acetophenone was found to be: in methanol, 0.10; in methylene chloride, 0.13; and in benzene, 0.10. A persistent minor photolysis product in all solvents was identified as α-tetrolone. A common origin in the triplet state of butyrophenone was indicated for all three products. Gamma irradiation of n-butyrophenone, in deaerated benzene solution, at a dose rate of 4.75×10^{17} ev/g min produced acetophenone and 1-phenylcyclobutanol. The effects of increasing gamma dose, anthracene, or naphthalene on reduction in yield are discussed. (F.J.H.)

26937 RADIATION-INDUCED CHAIN REACTIONS IN ALKALINE SOLUTIONS OF NITROUS OXIDE IN ALIPHATIC ALCOHOLS. Sherman, Warren V. (Soreq Nuclear Research Centre, Yavne, Israel). Chem. Commun., No. 9, 250-2(May 11, 1966).

The effects of potassium hydroxide concentration on the major gaseous products from gamma radiolysis of deaerated solutions of nitrous oxide in 2$^-$ propanol were determined. The products are hydrogen, nitrogen, and methane. It was found that at a given potassium hydroxide concentration the values of $G(N_2)$ and $G(CH_4)$ are dependent on the concentration of nitrous oxide. With $[KOH] = 5 \times 10^{-2}$ and $[N_2O] = 2 \times 10^{-2}$ and 2×10^{-1}M, $G(N_2)$ was 8.2×10^2 and 4.4×10^3, while $G(CH_4)$ was 5.3×10^1 and 2.7×10^2. Radiolysis of methanol solutions of nitrous oxide and potassium hydroxide was also studied. (F.J.H.)

26938 ISOTOPE EFFECTS IN THE RADIOLYSIS OF METHANOL–PERDEUTEROBENZENE SOLUTIONS. Ekstrom, A.; Garnett, J. L. (Univ. of New South Wales, Australia). Chem. Commun., No. 10, 290-1(May 25, 1966).

Both positive and inverse secondary isotope effects were observed in the yields of predominant products from the radiolysis of methanol–perdeuterobenzene solutions. The yields of H_2, HD, and CH_3D from methanol–perdeuterobenzene solutions are discussed. Positive isotope effects were found over the whole range of benzene concentration studied for those products that may involve rupture of C–H or C–D bonds. Inverse isotope effects were observed for those products that present evidence indicates may be formed by addition of radicals to benzene. Examination of yields suggested that a significant fraction of the apparently unscavengable molecular yield of hydrogen from methanol is formed by species derived from both methanol and benzene. (F.J.H.)

26939 RADIOCHEMICAL GRAFTING IN THE VITREOUS STATE. Chapiro, Adolphe; Jendrychowska-Bonamour, Anna-Maria; Roussel, Daniel. (CNRS, Bellevue, France). Compt. Rend., Ser. C, 262: 1132-4(Apr. 4, 1966). (In French).

Rapid polymerization was observed during irradiation, at −78°C, of mixtures of methyl methacrylate and polystyrene. The fractionation of the product showed the presence of grafted copolymers. Analogous results were obtained with mixtures of styrene, acrylonitrile, and polymethyl methacrylate. Polyvinyl chloride films inflated with styrene and acrylonitrile were irradiated at −78 and −196°C. In all cases grafting was detected and the reaction was more rapid with the acrylonitrile. (tr-auth)

26940 APPLICATION OF HIGH-ENERGY RADIATION IN THE TESTING OF INSULATORS. Muth, B. Elektrotechnika, 58: 251-7(1965).

Polyethylene was irradiated using a 500°C panoramic cobalt source, then the effects of the radiation were examined. Application of the optimal integral dose of 10 Mr required several days of uninterrupted operation, therefore the polyethylene film was irradiated in a vacuum ampoule to avoid oxidation of the surface. The degree of crosslinking was established by extraction tests. Prolonged thermal aging tests were made to check the efficiency of the stabilization of a high-pressure polyethylene. Up to 40 Mr there was practically no change found in the loss factor, dielectric constant, or dielectric strength of the material. Determination of the melting points showed that untreated polyethylene melted completely at 108°C, while the irradiated samples could be heated to 200°C without melting to a viscous liquid. Polyethylene films stretched by hand and heated to 110°C in a drying oven adhered perfectly to cables. (Hung. Tech. Abstr.)

26941 INVESTIGATIONS OF THE VISCOSITY OF γ-IRRADIATED OILS AND OIL SOLUTIONS. Kohn, R.; Leute, V.; Lueck, H. (Deutsche Forschungsanstalt fuer Lebensmittelchemie, Munich). Fette, Seifen, Anstrichmittel, 66: 824-7(Oct. 1964). (In German).

The limiting viscosities of solutions of tung oil in hexane and benzene and a formula showing the relation of viscosity to the concentration of diluted benzene solutions of tung oil are given. [Solutions were subjected to a dose of 10 Mrad from a ^{60}Co γ source at a dose rate of 0.4 Mrad/hr at temperatures of 35, 0, −80, and −196°C.] The increase in viscosity of dilute solutions of tung oil in benzene caused by irradiation showed that intramolecular cyclizations in dilute solutions are of no importance. The dependence of the viscosity increase on the irradiation temperature points out that the different triglyceride radicals move at different speeds during the irradiation. The chain reactions appear to have no effect on the polymerization of oils induced by irradiation. (OID)

26942 TRITIUM-SUBSTITUTION OF BENZENE BY Hg-PHOTOSENSITIZATION. Ghanem, N. A. (National Research Center, Dokki, Cairo); El-Ghany, A. H. Abd. Int. J. Appl. Radiat. Isotop., 17: 169-76(May 1966).

The substitution of hydrogen by tritium in benzene under direct and photosensitized uv irradiation is described. Under photosensitization a peak specific activity of tritiated benzene of 32 mC/g corresponding to a tritium fixation of 26% is reached after an exposure time of 2 hr. The results indicate that while, in the early stages, the recombination reaction $C_6H_5\cdot + T \rightarrow C_6H_5T^* \rightarrow C_6H_5T$ is predominant, prolonged irradiation times reduce the yield of tritiated benzene by the competing reactions $C_6H_5\cdot +$ hν → decomposition products, $C_6H_5\cdot + C_6H_5\cdot \rightarrow H_5C_6-C_6H_5$, and $C_6H_4T\cdot + C_6H_5\cdot \rightarrow TH_4C_6-C_6H_5$. (auth)

26943 ISOMERIZATION AND RADIOLYSIS OF HEXACHLORO-CYCLOHEXANE BY RADIATION CHEMISTRY. Elias, H.; Christ, O. (Technische Hochschule, Darmstadt, Ger.). Int. J. Appl. Radiat. Isotop., 17: 293-9(May 1966). (In German).

On irradiation of the isomers of hexachlorocyclohexane (HCH) with 1-Mev electrons at a dose of 10^8 to 2.4×10^9 rads, radiolysis was accompanied by isomerization to a small extent. The radiolysis and isomerization of α-HCH, β-HCH, and γ-HCH were investigated as a function of the dose. (auth)

26944 ENERGY TRANSPORT IN CARBOHYDRATES. PART I. MOLECULAR AGGREGATION EFFECTS. Phillips, G. O.; Baugh, P. J. (Univ. Coll., Cardiff, Wales). J. Chem. Soc., 4: 370-7(1966).

Acid production from solid anhydrous α-D-glucose on γ irradiation is dependent on the physical state in which the solid is prepared. From linear yield-dose curves, G(acid) for the normal polycrystalline form was 13.2, for the syrup 6.5, and for the freeze-dried state 2 to 4, according to the method of freeze-drying; α-D-glucose monohydrate showed initial G(acid) = 5.0. From infrared evidence it is probable that acid formation is a primary process occurring directly in the solid state. Reverse isotope-dilution analysis was used to estimate −G for the hexose when irradiated in the freeze-dried state. Electron spin resonance spectra indicated that the free-radical concentration is initially the same for the polycrystalline and freeze-dried forms, but that the decay is more rapid in the latter. For the long-lived free radicals, initial G(radical) is about 4. X-ray crystallography demonstrated that the polycrystalline and freeze-dried samples have indistinguishable chemical and crystallographic forms. Optical and electron microscopic examination revealed that a highly strained and imperfect lattice is produced on freeze-drying. The observations provide evidence for the existence of a mechanism of energy transport that is facilitated by a highly ordered crystal system. Lattice imperfections appear to act as exciton traps, resulting in appreciably less radiation decomposition. (auth)

26945 ENERGY TRANSPORT IN CARBOHYDRATES. PART II. RADIATION DECOMPOSITION OF D-GLUCOSE. Phillips, G. O.; Baugh, P. J.; Lofroth, G. (Univ. Coll., Cardiff, Wales). J. Chem. Soc., 4: 377-82(1966).

Direct isotope dilution analysis was employed to measure the −G-values for degradation of anhydrous α- and β-D-glucose and α-D-glucose monohydrate on γ irradiation. The anhydrous forms behaved identically, and initial −G-values of about 20 were obtained. The monohydrate was more resistant to radiation, and the initial −G is about 11. For each of the forms the −G-value decreased as irradiation was continued. After freeze-drying from aqueous solution, the anhydrous polycrystalline D-glucose produced was more resistant to radiation (initial −G ~7), and the results confirmed previous observations based on acid yields. Gluconic and glucuronic acids were identified and estimated among the acid products. Other aldehydic acids were also produced, and yield-dose curves for the acids indicated that fragmentation of D-glucose occurs during the initial chemical act. Although the overall yields of irradiation products varied for the various forms examined, no difference was observed in the nature of the products. The high decomposition rates observed for the hexoses indicated that these molecules provide favorable conditions for energy transport and undergo greater degradation in the solid state than in solution. A resonance-energy transport mechanism associated with the three-dimensional network of hydrogen bonds in the crystals is outlined. The mechanism accounts for the greater radiation stability of the monohydrate and the freeze-dried state (which contains considerable imperfection in the crystal lattice). (auth)

26946 ENERGY TRANSPORT IN CARBOHYDRATES. PART III. CHEMICAL EFFECTS OF γ-RADIATION ON THE CYCLOAMYLOSES. Phillips, G. O.; Young, M. (Univ. Coll., Cardiff, Wales). J. Chem. Soc., 4: 383-7 (1966).

On γ irradiation of solid cyclohepta-amylose, rupture of the cyclic α-1 → 4-glycosidic system occurred which did not follow the pattern of acid hydrolysis. No glucose was produced, and the products formed initially were maltohexaose and gluconic acid. The gaseous products were hydrogen, carbon dioxide, and carbon monoxide, and, from linear yield-dose curves, $G(H_2) = 3.1$, $G(CO) = 0.9$, and $G(CO_2) = 2.2$. For dry cyclohepta-amylose −G was 14.7. Water, even in a molar ratio of 1:1, with cyclic dextrin stabilized the dextrin to radiation damage, and −G fell to 7.5. For the dry dextrin and monohydrate, stoichiometric amounts of maltohexaose and acid were produced on irradiation. Further water up to a stoichiometric ratio of 10:1 water to dextrin did not significantly alter the −G-value but reduced the amount of acid produced. The radiation degradation of cyclohexa-amylose followed a similar pattern. On irradiation of cyclohepta-amylose in aqueous solution (8×10^{-3}M), there was a different distribution of products, and cleavage of the cyclic system was more akin to acid hydrolysis. (auth)

26947 ENERGY TRANSPORT IN CARBOHYDRATES. PART IV. ENERGY TRANSFER IN CYCLOHEPTA-AMYLOSE COMPLEXES. Phillips, G. O.; Baugh, P. J. (Univ. Coll, Cardiff, Wales). J. Chem. Soc., 4: 387-92 (1966).

Irradiation of cyclohepta-amylose produced a free radical whose electron spin resonance spectrum consisted mainly of a hyperfine structure doublet with a splitting of 3 to 4 gauss and a line width of 24 gauss. It is suggested that the ESR and chemical effects are best explained by production of a radical of the type $-O-(C_6H_{10}O_4)-O-$. Simultaneously, a carbonium ion is produced, which could react with water: $R^+ + H_2O \rightarrow ROH + H^+$. The effects of γ radiation on the inclusion complexes of cyclohepta-amylose were examined. For complexes with nitrophenols and iodobenzene the ESR spectrum of the irradiated cyclohepta-amylose disappeared and a spectrum different in form and intensity was observed. The complex with n-octanol did not show this behavior. The observations are explained on the basis of energy transfer from the carbohydrate to the armotic moeity, which also leads to a reduction in the chemical degradation of cyclohepta-amylose. Energy scavenging in this way offers a promising method of protecting carbohydrates from radiation damage. (auth)

26948 ENERGY TRANSPORT IN CARBOHYDRATES. PART V. MECHANISM OF INTERMOLECULAR ENERGY TRANSFER IN CYCLOAMYLOSE COMPLEXES. Phillips, G. O.; Young, M. (Univ. Coll., Cardiff, Wales). J. Chem. Soc., 4: 393-400(1966).

The factors that influence energy transfer in cycloamylose inclusion complexes were examined. Energy transfer, following γ irradiation, results in chemical protection of the dextrin with an efficiency that may be correlated with the position of the first singlet excited level (E_1) of the included molecule. Evidence is presented that intermolecular resonance transfer of electronic energy occurs via singlet states. It is considered unlikely that charged species or triplet states participate in the process. The form of the resonance curve sets a limiting value of N 5 ev for the energy of the collective excitation states formed in the cyclic dextrin on γ irradiation. The ESR spectra of irradiated 1-methylnaphthalene and benzene complexes suggested that H-atom attachment to the included molecule may occur. The energy-scavenging method which was devised can reduce −G(cycloamylose) from 17 to 1. (auth)

26949 THE ELECTRON SPIN RESONANCE SPECTRUM OF ELECTRON-IRRADIATED SINGLE CRYSTALS OF L-HISTIDINE HYDROCHLORIDE. Drews, R. E.; Rowlands, J. R. (General Dynamics/Astronautics, San Diego, Calif.). J. Chem. Soc., No. 4B, 296-7(1966).

The electron spin resonance spectra of the radical produced by electron irradiation of a single crystal of L-hystidine hydrochloride are reported, and the structure of the radical is discussed. (auth)

26950 AN ELECTRON SPIN RESONANCE STUDY OF AN ELECTRON-IRRADIATED SINGLE CRYSTAL OF N-AMIDINOALANINE. Drews, R. E.; Rowlands, J. R. (General Dynamics/Astronautics, San Diego, Calif.). J. Chem. Soc., No. 4B, 297-8(1966).

The electron spin resonance spectrum of the radical produced by electron irradiation of a single crystal of N-amidinoalanine is reported, and used to give information about the structure of the radicals. (auth)

26951 AUTO-OXIDATION PROCESS OF HYDROCARBONS IN THE CONDENSED PHASE UNDER γ IRRADIATION. I. KINETIC STUDY OF THE OXYGENATION OF CUMENE UNDER γ IRRADIATION. Durup, Marie (Univ., Paris, Orsay, France). J. Chim. Phys., 63: 476-84(Mar. 1966). (In French).

A kinetic study showed that the radioinduced auto-oxidation of cumene proceeds through a classical chain reaction;

at temperatures higher than 40°C a secondary chain-initiation occurs accompanied by the formation of an inhibitor. By a study of the different stages of this process it is shown that the γ-induced chain oxidation has no radiochemical specificity. (auth)

26952 AUTO-OXIDATION PROCESS OF HYDROCARBONS IN THE CONDENSED PHASE UNDER γ IRRADIATION. II. SENSITIZATION BY CARBON TETRACHLORIDE OF THE OXIDIZING RADIOLYSIS OF CUMENE. Durup, Marie (Univ., Paris, Orsay, France). J. Chim. Phys., 63: 485-8(Mar. 1966). (In French).

The addition of small quantities of carbon tetrachloride sensitizes the radiochemical auto-oxidation of cumene, giving rise to a strong increase of the γ-induced free radical yield. (auth)

26953 AUTO-OXIDATION PROCESS OF HYDROCARBONS IN THE CONDENSED PHASE UNDER γ IRRADIATION. III. COMPETITIVE CHAIN AUTO-OXIDATIONS. Durup, Marie (Univ., Paris, Orsay, France). J. Chim. Phys., 63: 489-93(Mar. 1966). (In French).

The γ-initiated chain auto-oxidation of cumene is slowed by addition of ethanol or isopropanol. It is shown that the cumyl-peroxy radicals easily abstract hydrogen atoms in the α position relative to the hydroxyl function, replacing normal chain-carriers by less reactive peroxy radicals issuing from the alcohols; these radicals may continue the kinetic chain but with some delay. Rate constants of the different elementary reactions are estimated. (auth)

26954 AUTO-OXIDATION PROCESS OF HYDROCARBONS IN CONDENSED PHASE UNDER γ IRRADIATION. IV. RADIOCHEMICAL OXYGENATION IN THE SOLID PHASE. Durup, Marie; Szwarc, Henri (Univ., Paris, Orsay, France). J. Chim. Phys., 63: 494-9(Mar. 1966). (In French).

A number of hydrocarbons were γ-irradiated at liquid nitrogen temperature in the presence of dissolved oxygen. The evolution of free radicals trapped in the solid matrix was studied by electron spin resonance during gradual warming. The transformation of hydrocarbon radicals to peroxy radicals $R^{\cdot} + O_2 \rightarrow ROO^{\cdot}$ was observed only when the solid was in vitreous form. (auth)

26955 STUDY OF IRRADIATED SILICA–ALUMINA CATALYSTS. Boury, Michel; Dalmai, Gisele; Imelik, Boris; Prettre, Marcel (CNRS, Villeurbanne, France). J. Chim. Phys., 63: 611-14(Apr. 1966). (In French).

Radiation effects on silica–alumina catalysts were studied by measuring ammonia chemisorption and the decomposition of formic acid. The catalytic activity increased and the ammonia chemisorption properties were changed if the temperature of thermal treatment previous to the action of radiation was 150°C. It was suggested that these modifications are connected with the elimination of superficial OH-groups or the migration of the bulk constitution water. If the major part of bound water is eliminated by heating the sample before irradiation at 400°C in vacuo, gamma radiation hardly modifies the properties of the solid. (auth)

26956 RADIATION-INDUCED FORMATION OF BUTYLTIN BROMIDES. Fentiman, A. F.; Wyant, R. E.; Jeffrey, D. A.; Kircher, J. F. (Battelle Memorial Inst., Columbus, Ohio). J. Organometal. Chem. (Amsterdam), 4: 302-7 (Oct. 1965).

Tin and 1-bromobutane can be induced by radiation to react directly. The principal product is dibutyltin dibromide. Relatively high G-values can be obtained if the tin surface is properly prepared and if the reaction is conducted at temperatures above 90°C. Higher yields are obtained with tin of small particle size and a systematic variation of the product distribution with tin mesh size was observed. Yields may be further increased by the use of HBr as an additive. (REIC)

26957 YIELD OF SCAVENGABLE HYDROGEN ATOMS FROM THE RADIOLYSIS OF SATURATED HYDROCARBONS. Holroyd, Richard A. (Atomics International, Canoga Park, Calif.). Contract AT(11-1)-GEN-8. J. Phys. Chem., 70: 1341-8(May 1966).

Studies were made to establish the extent that thermal hydrogen atoms are present in irradiated hydrocarbons. Ethylene, present as a solute in the hydrocarbon being irradiated, was used as a specific scavenger of hydrogen atoms. The yield of ethyl radicals, formed by addition of hydrogen atoms to ethylene, was measured with the $^{14}CH_3$ radical sampling technique. The value for G(H) was found to be 1.3 for n-pentane, 1.8 for 2,4-dimethylpentane, and 1.6 for 2,2,4-trimethylpentane. The ratio of G(H) to the total yield of cycloalkyl radicals was found to be 0.45 and 0.46 for cyclohexane and cyclopentane, respectively. If the total cycloalkyl radical yield was assumed to be 4.0, then these data indicated G(H) is 1.8 for the cycloalkanes. The yield of thermal hydrogen atoms apparently was not markedly dependent on structural factors. The yield of G(H) observed with ethylene for n-pentane and the cycloalkanes was less than one-half the yield reported in studies where scavengers such as methyl methacrylate and benzoquinone were used. The data suggested that the latter solutes reduce the hydrogen yield not only by scavenging thermal hydrogen atoms but also by reacting with other precursors of H_2. (auth)

26958 RADIOLYSIS OF OXALATE ALKALINE SOLUTIONS IN THE PRESENCE OF OXYGEN. Draganic, Z. D.; Draganic, I. G.; Kosanic, M. M. (Boris Kidric Inst. of Nuclear Sciences, Vinca, Yugoslavia). J. Phys. Chem., 70: 1418-25(May 1966).

The radiation yields of carbon dioxide, molecular hydrogen, and hydrogen peroxide were measured over the pH range from 9.5 to 14 in aqueous solutions of various oxalate and oxygen concentrations. The results obtained confirmed the change in the nature of the hydroxyl radical with increasing pH. The basic form was replaced by an ion radical O^- whose fate was determined in reactions with oxygen molecules and oxalate ions. The rate constant ratio $k_{O^- + O_2}/k_{O^- + C_2O_4^{2-}}$ was calculated from experimental data. A cube root dependence of the molecular hydrogen yields, measured as a function of the oxalic acid concentration, was observed. The experimental results were quantitatively consistent with a simple reaction scheme that allowed determination of the primary yields in water γ radiolysis in the pH region from 9.5 to 14. (auth)

26959 NITROUS OXIDE DOSIMETRY. EFFECTS OF TEMPERATURE, PRESSURE, AND ELECTRIC FIELD. Jones, F. T.; Sworski, T. J. (Union Carbide Corp., Tuxedo, N. Y.). J. Phys. Chem., 70: 1546-52(May 1966).

The N_2O dosimeter was calibrated for 1-Mev electrons by ionization measurements. $G_{N_2} = 10.0 \pm 0.2$, $G_{O_2} = 0.4$, $G_{NO} = 3.9 \pm 0.3$, and $G_{-N_2O} = 12.0 \pm 0.4$ were initial yields at 24°C and 600 torr. All yields increased with increasing temperature. The ratio G_{NO}/G_{O_2} increased from 1.0 at 24°C and 600 torr to >2.0 above 150°C. Therefore, because of the reaction between NO and O_2, the volatile products after trapping at −196°C consisted of only N_2 and O_2 at 24°C and only N_2 and NO above 150°C. Although G_{-N_2O} and G_{N_2} were essentially independent of pressure from 50 to 600 torr, G_{O_2} decreased and G_{NO} increased with decreasing pressure. The G value for O_2 volatile after trapping at −196°C decreased from 2.0 to 600 torr to 0.9 at 50 torr at 24°C. Product yields were increased by electrical fields insufficient to induce secondary ionization but sufficient to induce electronic excitation. The pressure dependence for G_{N_2} and G_{NO} at $X/p \sim 11$ v cm^{-1} $torr^{-1}$ was consistent either with ultimate dissociative electron capture of all electrons and bimolecular deactivation of N_2O^* or with no significant electron capture and termolecular deactivation of N_2O^* with $\tau_{N_2O^*} \sim 10^{-9}$ sec. (auth)

26960 POLYMER FORMATION IN IRRADIATED LIQUID PYRIDINE. Pearce, Carol K.; Ellison, Joseph E. Jr. (Army Electronics Command, Fort Monmouth, N. J.). J. Phys. Chem., 70: 1582-7(May 1966).

Pyridine was exposed at room temperature to γ or x radiation with total dosages of 3.5 to 73×10^{19} ev/g, using dose rates from 2.47×10^{17} to 1.46×10^{21} ev/g hr. The molecular weight of the polymer formed increased with increasing dose, evidence of hydrogenation was found, and the polymer yield $G_{-\text{pyridine}} = 3.66$ was determined. Three bipyridine isomers were detected in the polymer. The bipyridine

yields were dependent on total dose and also on dose rate. The experimental results were consistent with a mechanism involving C_5H_4N · and C_5H_6N · radicals. (auth)

26961 POSITIVE HOLE MIGRATION AND TRAPPING IN γ-IRRADIATED 3-METHYLPENTANE AT –196 DEG. Skelly, David W.; Hamill, William H. (Univ. of Notre Dame, Ind.). J. Phys. Chem., 70: 1630-3(May 1966).

In γ-irradiated glassy 3-methylpentane at –196°C, toluene formed a cation T^+ with absorption maxima at 1075 and 425 mμ and carbon tetrachloride formed a cation C^+ with one band at 480 mμ. The formulas of these ionic species are unknown. Both additives trapped electrons, but no absorption attributable to anions was observed. At 2.4 mole % toluene, addition of carbon tetrachloride to 2.6 mole % increased $OD(T^+)$ markedly, which was attributable to increased stabilization of T^+ by electron trapping. At 2.6 mole % CCl_4, adding up to 2.4 mole % toluene tended to saturate $OD(T^+)$ due to increased hole trapping, while $OD(C^+)$ remained constant. The facts suggested that carbon tetrachloride traps only excited holes, while toluene traps only ground-state holes. Other types of charge migration are considered. (auth)

26962 RADIATION CHEMISTRY OF AQUEOUS SOLUTION OF SILVER ION. Czapski, Gideon; Allen, A. O. (Brookhaven National Lab., Upton, N. Y.). J. Phys. Chem., 70: 1659-62(May 1966). (BNL-9568).

Silver perchlorate solutions were irradiated using two ^{60}Co gamma sources with dose rates of 5800 and 250 rads/min. The precipitate that was formed on irradiation was dissolved in 30% HNO_3 containing $NaNO_2$ to catalyze the dissolution of metallic silver, and the resulting solution was titrated for silver using 0.05N KCNS. The limit of detection was 0.5μ mole. The yields of metallic silver were small at low concentration but increased with increasing concentration. Effects of air, ethanol, hydrogen, hydrogen peroxide, and nitrite ion on the yield of metallic silver are discussed. No effect of dose rate was found in any of the yields measured. All solutions were neutral and unbuffered; pH effects were not studied. (F.J.H.)

26963 SHORT-CHAIN BRANCHING IN γ-RADIATION-INDUCED POLYMERIZATION OF ETHYLENE. Machi, Sueo; Tamura, Takashi; Hagiwara, Miyuki; Gotoda, Masao; Kagiya, Tsutomu (Japan Atomic Energy Research Inst., Gunma). J. Polym. Sci. Pt. A-1, 4: 283-91(Feb. 1966).

In an attempt to elucidate the mechanism of chain-branch formation in the polymerization of ethylene, the effect of reaction conditions on short-chain branching in γ-induced polymerization of ethylene was investigated by using infrared spectroscopy. The concentration of methyl groups, i.e., the frequency of short-chain branching, increased with temperature and pressure and was independent of ethylene conversion to polymer and radiation intensity. The number of methyl groups per polymer molecule increased almost proportionally with the degree of polymerization. These facts indicated that short-chain branching occurs mainly by the mechanism of intramolecular hydrogen transfer. The effect of pressure on the rate of chain branching can be postulated by considering the transition state to be six-membered rings in hydrogen transfer reactions. The activation energy of chain branching was found to exceed that of propagation by 6 kcal/mole. (auth)

26964 ALTERNATIVE COPOLYMERIZATION OF AZIRIDINES AND CARBON MONOXIDE BY γ-RAY IRRADIATION. Kagiya, Tsutomu (Kyoto Univ.); Narisawa, Shizuo; Ichida, Taizo; Fukui, Kenichi; Yokota, Hisao; Kondo, Masatsune. J. Polym. Sci. Pt. A-1, 4: 293-9(Feb. 1966).

The copolymerization of carbon monoxide and aziridines such as ethylenimine and propylenimine was carried out by γ-irradiation. Aziridines and carbon monoxide were allowed to copolymerize under γ radiation from a ^{60}Co source and gave a crystalline solid copolymer. The yield of the copolymer increased with reaction temperature. The composition of the copolymers obtained did not depend on the feed ratio of monomers and was found to be almost equimolar. The copolymer of ethylenimine and carbon monoxide melted at about 322 to 335°C with decomposition and had an infrared spectrum identical with that of poly-β-alanine obtained by the hydrogen-migration polymerization of acrylamide. The hydrolyzed product of the ethylenimine–carbon monoxide copolymer was confirmed to be β-alanine by paper chromatography. These results led to the conclusion that the copolymerization of aziridines and carbon monoxide took place alternatively by γ-irradiation, and produced crystalline poly-β-alanines. (auth)

26965 PYROLYSIS OF VINYL AND VINYLIDENE FLUORIDE POLYMERS: INFLUENCE OF PRIOR γ IRRADIATION. Wall, L. A.; Straus, S.; Florin, R. E. (National Bureau of Standards, Washington, D. C.). J. Polym. Sci. Pt. A-1, 4: 349-65(Feb. 1966).

Quantitative comparisons were made between the rates of thermal volatilization of several fluoropolymers before and after exposure to γ radiation. The effects of γ radiation on poly(vinyl fluoride) and poly(vinylidene fluoride) were also investigated by swelling and sol-gel ratios. With both these polymers and with polytrifluoroethylene, crosslinks occurred predominantly, though there was an appreciable number of scissions. The rates of volatilization and char formation were enhanced by γ radiation, whereas the previously studied polytrifluoroethylene did not produce more char on irradiation, although radiation did accelerate its volatilization. It was concluded that in polytrifluoroethylene the enhanced rates of volatilization occur by a different mechanism than in the case of the vinyl and vinylidene fluoride polymers. (auth)

26966 γ-RADIATION-INDUCED IONIC POLYMERIZATION OF PURE LIQUID STYRENE. Potter, R. C. (Brookhaven National Lab., Upton, N. Y.); Johnson, C. L.; Metz, D. J.; Bretton, R. H. J. Polym. Sci. Pt. A-1, 4: 419-30(Feb. 1966). (BNL-10046).

Pure liquid styrene exhibits kinetic behavior under γ-irradiation that can be described in terms of an ionic mechanism. A linear dependence of the rate of polymerization on the dose rate and the independence of molecular weight on the same parameter were observed. The thermal and ultraviolet initiated polymerization of a monomer prepared under the same stringent conditions was compared. The highest rate of conversion to polymer was 400%/hr at a dose rate of 10^6 rads/hr, corresponding to a $G_{(-monomer)} \approx 40{,}000$. (auth)

26967 RADIATION-INDUCED cis-trans ISOMERIZATION OF POLYISOPRENES AND TEMPERATURE DEPENDENCE OF THE EQUILIBRIA. Tsurugi, Jitsuo; Fukumoto, Tsugio; Yamagami, Masayuki; Itatani, Hiroshi (Radiation Center of Osaka Prefecture). J. Polym. Sci. Pt. A-1, 4: 563-71(Mar. 1966).

The cis-trans interconversion of polyisoprenes in solutions induced by γ irradiation in the presence of a sensitizer, which is any one of organic bromides or n-butyl mercaptan, was studied by using hevea and gutta percha as starting substances. The percentage cis remaining or converted after irradiation were determined by the infrared absorption. The equilibrium constants for the interconversion at 22, 60, and 100°C were found to be 3.00, 5.25, and 7.33, respectively. The first-order rate constants for cis → trans and trans → cis isomerizations at 22°C were calculated to be 9.05 and 2.91, respectively. The results were interpreted by the mechanism proposed by Golub, according to which the double bonds from π complexes with radiolytic fragments from sensitizers give a radical transition state capable of interconversion. Results showed that heating shifted the equilibrium toward trans isomer and are not in accord with the mechanisms of the radio-induced isomerization of polybutadiene of Golub and those for photoisomerization of aromatic azo compounds. (auth)

26968 γ-IRRADIATION OF POLY(ETHYLENE TEREPHTHALATE). I. YIELDS OF GAS AND CARBOXYL GROUPS. Burow, S. D. (Research Triangle Inst., Durham, N. C.); Turner, D. T.; Pezdirtz, George F.; Sands, George D. J. Polym. Sci. Pt. A-1, 4: 613-22(Mar. 1966).

Poly(ethylene terephthalate) was exposed in vacuo to γ radiation from a ^{60}Co source at a dose rate of 0.02 Mrad/min, and an ambient temperature of 47°C. Gaseous products were analyzed in a mass spectrometer and carboxyl groups estimated by titration with NaOH and by infrared analysis. Initial G values were $-COOH = 0.77$, $CO_2 = 0.17$, $CO = 0.11$, $H_2 = 0.015$, and $CH_4 = 0.003$. All these values decreased markedly with increasing dose except $G(CO)_2$, which, roughly, was maintained up to 5000 Mrad. It was found that the rate of formation of $-COOH$ groups at low doses was much too high to fit a first-order reaction scheme. However, a better fit was obtained over a range of higher doses (ca 100 to 5000 Mrad). (auth)

26969 γ IRRADIATION OF SILOXANE POLYMERS IN AIR AND VACUUM AT SEVERAL TEMPERATURES. Jenkins, Robert (Northrop Space Labs., Hawthorne, Calif.). J. Polym. Sci. Pt. A-1, 4: 771-81(Apr. 1966).

The effects of γ irradiation on two polysiloxanes in environments of air and vacuum at several selected temperatures were studied. The physical property monitored during the γ irradiation of the two polysiloxanes was the change in dynamic modulus which, in turn, is proportional to the change in the number of elastically effective chains in the polymer network. The measurements were accomplished by recording in situ the free-end response of the polymeric cantilever reeds in forced resonance at and near their fundamental frequency of resonance. The apparent energy of activation of crosslinking for the polydimethylsiloxane polymer was found to be 0.56 kcal/mole in vacuum over a limited temperature range, and 3.5 kcal/mole in air. For the polydimethyl-diphenylsiloxane polymer, the apparent energy of activation was found to be about 1.3 kcal/mole in vacuum, whereas in air the polymer response was complex, displaying both scissioning and crosslinking reactions so that a value could not be obtained. The ability of the pendant phenyl groups to reduce the effective crosslinking rate was found to be sensitive to both temperature and environment. (auth)

26970 X-RAY AND NMR MEASUREMENTS ON IRRADIATED POLYTETRAFLUOROETHYLENE AND POLYCHLOROTRIFLUOROETHYLENE. Peffley, W. M.; Honnold, V. R.; Binder, D. (Hughes Aircraft Co., Fullerton, Calif.). J. Polym. Sci. Pt. A-1, 4: 977-83(May 1966).

The effects of ^{60}Co γ radiation on polytetrafluoroethylene (PTFE) and polychlorotrifluoroethylene (PCTFE) were studied for radiation doses up to 940 Mrad. The dependence per cent crystallinity on irradiation level was determined from x-ray analysis. An initial increase in crystallinity in PTFE, attributable to chain scission in the amorphous phase of the material, was found, followed (above 300 Mrad) by a gradual decrease associated with a disordering of the crystallites. No initial increase was observed for annealed samples of PCTFE due to the large initial value of the per cent crystallinity. Above 200 Mrad the crystallinity was found to decrease with accumulated dose. Nuclear magnetic resonance measurements on PTFE indicated a radioinduced broadening of the amorphous component of the NMR line appearing to maximize above 700 Mrad. Similar measurements on PCTFE showed a narrowing of the crystalline component of the NMR line and subsequent appearance of the amorphous component at approximately 200 Mrad. The data indicated that the radioinduced behavior of PTFE and PCTFE is similar above 200 Mrad. (auth)

26971 SOME VISCOELASTIC PROPERTIES OF SILOXANE POLYMERS DURING IRRADIATION. Jenkins, R. K. (Northrop Space Labs., Hawthorne, Calif.). J. Polym. Sci. Pt. A-2, 4: 41-52(Feb. 1966).

The dynamic moduli, E'_{dyn}, and loss tangents, tan δ, of polydimethylsiloxane and polydimethyldiphenylsiloxane polymers were investigated by an in situ technique during γ-irradiation. These viscoelastic properties were calculated and plotted as a function of irradiation exposure time by measuring the free end displacements and resonance frequencies of polymeric cantilever reeds. The reeds were swept through a small frequency range from about 20 to 100 cycles/sec. The moles of effectively elastic chains per unit volume (ν) of the two unfilled polysiloxanes were calculated from in situ modulus data and compared to values obtained utilizing the swelling technique. The approximate molecular weights between entanglements, M_e, of these unfilled polymers were determined by extrapolation of moduli data to zero radiation exposure. The addition of a large silica filler, SiO_2, into the polymers did not alter the crosslinking rates, and the filler did not enter into polymer-filler bonding. (auth)

26972 EFFECT OF STRUCTURE ON RADIATION DAMAGE IN ISOTACTIC POLYBUTENE-1. Rubin, I. D.; Huber, L. M. (Texaco Inc., Beacon, N. Y.). J. Polym. Sci. Pt. B, 4: 337-42(May 1966).

Electron spin resonance studies on hexagonal and tetragonal modifications of polybutene-1 after irradiation are reported. The two polymorphs were irradiated at −196°C with gamma rays from ^{60}Co. The irradiation time was 100 min and the total dose was 10^6 rads. The unstable tetragonal modification was always irradiated immediately after it was prepared to avoid any changes to the stable hexagonal form. The ESR spectra of the hexagonal and tetragonal modifications were obtained 5 to 6 min after the irradiated samples were removed from liquid nitrogen. The ESR spectrum of the hexagonal form was characterized by the presence of an eight-line pattern with an overall width of 133 gauss. The linewidth was ~10 gauss, and the hyperfine splitting ~19 gauss. The spectrum of the tetragonal modification consisted of ~12 lines with ~ equal splittings of 9.5 gauss; its overall width was 103 gauss. The infrared spectrum of the irradiated tetragonal polymorph was identical to that of the original material. (F.J.H.)

26973 RADIATION-INDUCED POLYMERIZATION OF MALEIMIDE. Kagiya, Tsutomu; Izu, Masatugu; Kawai, Syunzou; Fukui, Kenichi (Kyoto Univ.). J. Polym. Sci., Pt. B, 4: 387-92(June 1966).

Results of radioinduced bulk polymerization of maleimide in both the liquid and solid states are presented. In solid-state polymerization, the polymer was obtained as a white powder over a wide range of conversion. It was soluble in N,N′-dimethylformamide and dimethylsulfoxide. In the liquid state, the polymer was obtained as a glass-like transparent mass when the polymer yield reached high conversion. Effects of irradiation temperature on polymer yield and intrinsic viscosity, post polymerization, and two-stage irradiations at different temperatures and at various dose rates are discussed. (F.J.H.)

26974 MECHANISM OF THE DEPOLYMERIZATION OF POLYTETRAFLUOROETHYLENE WITH PYROLYTIC AND RADIOLYTIC INITIATION. Florin, Roland E.; Parker, Midgett S.; Wall, Leo A. (National Bureau of Standards, Washington, D. C.). J. Res. Nat. Bur. Stand., 70A: 115-31(Mar.-Apr. 1966).

The rate of decomposition of polytetrafluoroethylene, exposed to gamma radiation in a flowing helium atmosphere, was studied in the range of temperatures from 330 to 450°C, dose rates of 0.1 to 7.6 MR/hr and sample thicknesses of 0.0006 to 0.01 cm. Rate measurements were made with a thermal conductivity cell in the exit stream, which recorded essentially the difference between the thermal and radioinduced rate, in total molecules of volatiles per second. At temperatures below ~400°C, the volatile products were a complex mixture. Above 400°C, tetrafluoroethylene was the major product, and the radioinduced rate had an activation energy of 70 to 84 kJ/mol. The radioinduced rate is proportional to square root of dose rate, after appropriate allowance for the thermal initiation is made. Analysis of the results suggested that the rate of the thermal initiation has a very high pre-exponential factor, 10^{28} to 10^{30} s^{-1}. The activation energy for termination is large, $E_4 > 155$ kJ/mol. Diffusion and reverse reaction appear to be minor factors above 400°C, but a surface reaction may be important. The thermal decomposition mechanism seems to consist of random initiation, termination by bimolecular recombination, and a short kinetic chain (13 at 480°C). (auth)

26975 MECHANICAL PROPERTIES OF IRRADIATED ALKALI HALIDE CRYSTALS. Nadeau, John S. (Gen-

eral Electric Research and Development Center, Schenectady, N. Y.). pp 149-68 of Nuclear Applications of Nonfissionable Ceramics. Boltax, Alvin; Handwerk, J. H. (eds.). Hinsdale, Ill., American Nuclear Society, 1966.

Most of the fundamental studies of radiation hardening in ionic crystals were made on alkali halides. These studies helped to expose some of the factors that influence the strength and brittleness of ionic crystals as well as their sensitivity to radiation damage. As viewed from the perspective of mechanical properties measurements, radiation damage may be either a solution-hardening or a precipitation-hardening phenomenon. The experience with alkali halides encompassed primarily solution hardening effects and most of the results may be adequately interpreted in terms of solution hardening theories. In turn, certain characteristics of radiation-created defects may be deduced by the way that they affect mechanical properties. In this case, moving dislocations are used to probe a crystal for the extremely short-range forces that most effectively impede dislocation motion. Thus, mechanical properties measurements provide a defect sensor, the dislocation, capable of perceiving strains on an atomic scale. The measured changes of mechanical properties in irradiated crystals (which might be termed the changes in engineering parameters), and what was learned about radioinduced defects by this method are described. (auth)

26976 CHANGES IN COMPRESSIVE AND TENSILE STRENGTH AS WELL AS IN SORPTION OF WOOD CAUSED BY γ-RADIATION. Burmester, Arno (Bundesanstalt fuer Materialpruefung, Berlin). Materialpruefung, 6: 95-9(Mar. 1964). (In German).

After a survey of earlier test results on the effects of γ radiation on wood, new studies are recorded. In these investigations, the compressive and tensile strength as well as the sorption behavior of pine, spruce, and beech were examined in the γ-radiation range between 10^1 and 2.9×10^8 r. There was an insignificant increase in tensile strength, compressive strength, and balanced moisture content when low radiation doses were used. With increasing dosage at first the tensile strength was reduced. The compressive strength was maintained up to high doses. An influence on sorption was observed throughout the examined range of radiation. After irradiation with doses from 10^2 to 5×10^3 r the capacity for water-vapor sorption increased; with further increasing irradiation treatment the balanced moisture continuously decreased. (auth)

26977 REACTIVITY AROMATIC COMPOUNDS TOWARDS HYDROGEN ATOMS. Anbar, M.; Meyerstein, D.; Neta, P. (Weizmann Inst. of Science and Soreq Nuclear Research Center, Rehovoth, Israel). Nature, 209: 1348(Mar. 26, 1966).

The reactivity of aromatic compounds toward hydrogen atoms is investigated in order to study the nature of the PhX + H reaction. The specific rate constants of substituted benzenes with hydrogen atoms were determined by competition kinetics, using isopropanol as the competing compound. A gamma radiolytic method was used for the investigation. (B.G.D.)

26978 RADIATION REACTIONS IN POLYMERS. Schnabel, Wolfram (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Naturwissenschaften, 53: 166-71(1966). (In German).

Radioinduced reactions in solid polymers and in polymers in solution are reviewed. Radiation-chemical buffer copolymerization is also considered. (J.S.R.)

26979 POLARIZATION AND CONDUCTIVITY IN KCl. Kim, Hi Gyu (Kyung Hee Univ., Seoul). New Phys. (Korea), 5: No. 2, 9-13(Dec. 1965).

The time dependent polarization effect and conductivity of pure KCl crystals, in the temperature range between 30 and 170°C were studied. The validity of Ohm's law and the superposition principle were examined. The dielectric relaxation of a dipolar nature was studied and compared with nonlinear polarization effects. The conductivity and activation energy were evaluated in the low temperature region. The effects of color centers (F centers) created with x radiation were studied in order to check the partial blocking of ionic flow at the surface of the crystal. It was concluded that linear dielectric relaxation holds well, although it is not necessarily true in higher temperature range. (auth)

26980 CHLORAL HYDRATE: 800-RAD DOSIMETER. Boyd, W.; Brownell, L. E.; Farvar, M. A. (Univ. of Michigan, Ann Arbor). Nucleonics, 24: No. 5, 6-7(May 1966).

Studies indicated that an inexpensive low-dose chemical dosimetry system can be based on measurements of chloral hydrate solutions with a Beckman pH meter. To explore the usefulness of chloral hydrate solutions for measuring doses of 800 rads or less, 0.2M solutions were irradiated with various doses over the range 80–800 rads, with exposures given at different dose rates. A linear relation between pH and dose was found. (P.C.H.)

26981 PRIMARY PROCESSES IN RADIATION CHEMISTRY AS STUDIED BY MASS SPECTROMETRY. VI. ION RECOMBINATION IN TETRAHYDRONAPHTHALENE RADIOLYSIS IN THE LIQUID PHASE. Wincel, Henryk; Kecki, Zbigniew (Inst. of Nuclear Research, Warsaw). Nukleonika, 11: 1-5(1966).

Thermalization of electrons knocked out from the molecules and ion-electron recombination in the tetrahydronaphthalene radiolysis process in the liquid phase are discussed. The $G(ion^+)$ value for the time scale 1.92×10^{-13} sec was evaluated to be 0.7. (auth)

26982 REDUCTION OF RARE-EARTH IONS BY RADIATION IN FLUORITE-TYPE CRYSTALS WITH TWO ACTIVATORS. Arkhangelskaya, V. A.; Feofilov, P. P. Opt. Spectros. (USSR) (Engl. Transl.), 20: 90-1(Jan. 1966). Translated from Opt. Spektros., 20: 169-71(Jan. 1966).

The results of an investigation on the reduction of rare-earth activating ions in fluorite-type crystals in the presence of a second rare-earth activator are presented. The details of this process were demonstrated using the reduction of the Nd^{+3} ions in SrF_2 in the presence of Gd, Dy, Ho, Tm, and Er. (B.G.D.)

26983 BEHAVIOR OF HIGH POLYMERS WITH RESPECT TO ENERGETIC RADIATION. Heinze, D. (Badische Anilin and Soda-Fabrik AG, Ludwigshafen, Ger.). pp 135-9 of Physikertagung 1965 Frankfurt (M)-Hoechst, Okt. 4-9. Vorabdrucke von Kurzfassungen der Fachberichte. Stuttgart, B. G. Teubner Verlagsgesellschaft mbH, 1965. (In German).

The primary absorption of energetic radiation and the secondary and subsequent reaction in high polymers were briefly summarized. The structural dependence of these reactions was indicated. Cross linking under oxygen excess and the changes and the crystallinity, the density, and the mechanical properties resulting from the cross linking were treated. The change of the crystallinity was affected by the temperature during the irradiation. In the presence of oxygen the ratios become complicated since the property changes then depend on the dose output and the geometry of the irradiated sample. The question of the increase of the radiation stability and the problem of the sensitization against energetic radiation were discussed. (tr-auth)

26984 RADIATION PROTECTION OF AQUEOUS POLYETHYLENE OXIDE SOLUTIONS BY THIOUREA. Charlesby, A.; Kopp, P. M. (Royal Military Coll. of Science, Swindon, Eng.). Proc. Roy. Soc. (London), Ser. A, 291: No. 1424, 129-43(Mar. 29, 1966).

Dilute aqueous solutions of polyethylene oxide, when exposed to γ radiation, form a gel structure. Analysis shows that unlike the situation for polyvinylpyrrolidone solutions, this reaction results primarily from the energy absorbed in the polymer and not indirectly via the radiolytic products of water. The G value for formation of polymer radicals capable of cross-linking equals 4.46. The minimum radiation dose required for gelation is greatly increased when small amounts of thiourea are present. This "stabilization protection" is found to depend markedly on radiation intensity as well as on polymer and additive concentration. Over a wide range of these variables the results conform with those expected for competitive reactions between two

polymer radicals (R·) and a polymer radical and additive (A). Under steady state conditions the results agree with the equation $k_1Ic = k_2(R^{\cdot})^2 + k_3(R^{\cdot})$ (A), where $k_3/\sqrt{k_2} = 0.2$. The mathematical treatment developed may be applicable in the analysis of other first and second-order competitive reactions. (auth)

26985 RADIOLYSIS OF DILUTE AQUEOUS THIOUREA SOLUTIONS. Charlesby, A.; Kopp, P. M.; Read, J. F. (Royal Military Coll. of Science, Swindon, Eng.). Proc. Roy. Soc. (London), Ser. A, 292: 122-33(May 3, 1966).

The reactions of dilute aqueous thiourea solutions were followed in a range of γ radiation doses and dose rates, and in the absence and presence of oxygen. The rapid destruction of thiourea confirmed that the effect is primarily indirect, and almost independent of concentration, and dose rate over the range from 10 to 500 mg/l. The breakdown products of thiourea can react further. In the presence of oxygen the loss of thiourea is more rapid, and different products are formed. (auth)

26986 OXIDATION OF THE RAFFINATED FRACTION OF PETROLEUM INITIATED WITH ITS RADIOLYSIS PRODUCTS. Bryl-Sandelewska, Teresa; Kecki, Zbigniew; Minc, Stefan; Nowak, Zofia; Stachowicz, Waclaw; Wincel, Henryk (Inst. for Nuclear Research, Warsaw). Przem. Chem., 45: 127-31(Mar. 1966). (In Polish).

Kinetics of the oxidation process of a petroleum fraction raffinate, boiling within the 290 to 320°C range, initiated by adding products of gamma radiolysis of this fraction, was studied. The dependence of the oxidation efficiency on the amount of products added and the temperature was examined. The influence of the concentration of aromatic hydrocarbons in oxidized oil on the yield of the oxidation products was determined. It was established that the initiation efficiency of products derived from oil-water emulsion irradiation was higher than that of products obtained from pure oil under the same conditions. (auth)

26987 DIPHOSPHORUS TETRACHLORIDE FORMED BY NEUTRON IRRADIATION OF PHOSPHORUS TRICHLORIDE. Sandoval, A. A.; Weeks, R. W.; Moser, H. C. (Univ. of Missouri, Kansas City. Kansas State Univ., Manhattan). Radiochim. Acta, 5: 42-4(Mar. 1966).

Phosphorus trichloride and phosphorus trichloride solutions containing either diphosphorus tetrachloride or white phosphorus as scavengers were subjected to thermal neutron irradiation (7×10^9n cm^{-2} sec^{-1}) for 10-min periods. Diphosphorus tetrachloride carrier was added to the neutron-irradiated phosphorus trichloride and separated by vacuum distillation. The results indicated that 20% of the ^{32}P is present as $^{32}PPCl_4$ in the samples without scavenger. As much as 50% $^{32}PPCl_4$ was found in the samples with scavenger. (auth)

26988 FORMATION OF BIPHENYL IN γ RADIOLYSIS OF BENZENE. Srivastava, S. B. (Atomic Energy Establishment, Trombay, India). Radiochim. Acta, 5: 50-1 (Mar. 1966).

Yields of biphenyl from radiolysis of benzene using γ radiation are described. The G values obtained were found to be reproducible within ±3%. The value for G (biphenyl) for pure benzene was 0.062, which is in agreement with the values previously reported. The results of experiments with a wide range of scintillator (PPO) concentrations are given. The effect of addition of organic scintillators on G (biphenyl) is given. The effects of trans-2-butene and naphthalene on the value of G (biphenyl) are discussed. (F.J.H.)

26989 THERMAL ANNEALING OF ^{82}Br IN NEUTRON-IRRADIATED TRIBROMOBENZENE. Siekierska, K. E.; Halpern, A. (Inst. of Nuclear Research, Warsaw). Radiochim. Acta, 5: 51-2(Mar. 1966).

Thermal annealing of recoil bromine-82 in neutron-irradiated tribromobenzene produced is described. Results are reported, including the observation of the shape of the annealing curves, which differs from that found normally for other crystalline systems. The labeled products were separated by reversed-phase partition chromatography and the activity was counted with a well-type scintillation counter. Chromatograms for neutron-irradiated tribromobenzene and the yields of individual radioactive products are presented. The effects of temperature and time on the plateau values are discussed. (F.J.H.)

26990 DIFFUSION-LIMITED ANNEALING OF CHEMICAL RADIATION DAMAGE IN LEAD NITRATE. Mohanty, S. R. (Banaras Hindu Univ., Varanasi, India). Radiochim. Acta, 5: 54-5(Mar. 1966).

Data on annealing of chemical damage in electron irradiated lead nitrate according to the Waite model are presented. The value of the activation energy calculated from the temperature dependence of $\varphi/t^{1/2}$, where φ is fraction of defects annealed, was 25.1 kcal, which was lower than that obtained in the Fletcher-Brown treatment of the data. (F.J.H.)

26991 PULSE RADIOLYSIS. Christensen, Hilbert (AB Atomenergie, Studsvik, Sweden). Svensk Kem. Tidskr., 77: 400-15(1965). (In Swedish).

The technique of pulse radiolysis is described, with particular emphasis on the production of transient species, determination of their absorption spectra, and kinetic studies of their rates of formation and reactions. The discovery of the hydrated electron is recounted and some of its reactions are discussed. Many reactions of other transient species in aqueous solution and in organic solution are reviewed. The rate constants of reactions of the hydrated electron with 23 inorganic compounds and 21 organic compounds are tabulated. Rate constants for other inorganic radicals with inorganic compounds are tabulated for 18 cases. Constants for other organic compounds are tabulated for 14 cases. Illustrations give rate constants of the hydrated electron, H, and OH with various inorganic and organic compounds, and rate constants for the hydrated electron with a variety of organics and biochemicals. (BBB)

26992 PROTON RADIOLYSIS OF CARBON MONOXIDE. Anderson, A. R.; Best, J. V. F.; Willett, M. J. (Atomic Energy Research Establishment, Harwell, Eng.). Trans. Faraday Soc., 62: 595-609(Mar. 1966).

The radiation chemistry of CO was studied, using principally low-energy protons from a Van de Graaff accelerator, as a function of dose rate, temperature, and small amounts of additives (CO_2 and O_2). At dose rates higher than those used in previous work a true dose-rate inhibition effect was found, which was interpreted on the basis of competition between second-order and first-order processes. The effect of CO_2 on yields was negligible at concentrations up to 0.5% by volume but initial yields were extremely sensitive to traces of O_2, particularly at low dose rates. Increased temperature reduced yields of solid and increased yields of CO_2, but this effect was controlled mainly by subsequent thermal decomposition of the solid. The empirical composition of the solid was unaffected by changes in dose rate, and varied from $(C_3O_2)_n$ at room temperature to essentially pure carbon at temperatures >450°C. Nucleation of the solid occurred predominantly in the gas phase. The relative importance of ionic and excitation processes is discussed. (auth)

26993 PROTON RADIOLYSIS OF CARBON DIOXIDE. Anderson, A. R.; Best, J. V. F. (Atomic Energy Research Establishment, Harwell, Eng.). Trans. Faraday Soc., 62: 610-18(Mar. 1966).

The radiation decomposition of pure CO_2 in the absence of added scavengers was studied at high dose rates using protons from a Van de Graaff accelerator. Primary decomposition yields $G(CO) = 4.25 \pm 0.25$ and $G(O_2) = 2.24 \pm 0.1$ were measured in a fast flow system. Irradiations under static conditions showed that these yields are obtained when the concentrations of products in the irradiated gas are <4% of the relevant steady-state concentrations. Supporting work on the $^{14}CO/CO_2$ radioinduced exchange reaction confirmed these primary yields and demonstrated the importance of a species derived from molecular O_2 in initiating the radioinduced back reaction involving oxidation of CO. (auth)

26994 EFFECT OF RADIATION ON POLYETHYLENE ADHESION TO ALUMINUM. Spitsyn, Vikt. I.; Zubov, P. I.;

Kabanov, V. Ya.; Grozinskaya, Z. P. (Inst. of Physical Chemistry, Academy of Sciences, USSR). Vysokomol. Soedin., 8: 604-12(Apr. 1966). (In Russian).

Irradiation of polyethylene coating on aluminum foil increased its adhesion. If after irradiation the coating was heated to the melting point the adhesion rose even more in comparison with the initial rise. Irradiation of polyethylene powder following casting of the coating also brought about adhesion enhancement but to a less extent than irradiation. The adhesion increase is explained by radioinduced oxidation of polyethylene in the contact zone favoring carbonyl group orientation in respect to the oxide film of aluminum. Besides this there is increased flexibility of the chains in radiation field facilitating the adhesive-substrate contacts. The adhesion decrease at further irradiation is related to the polyethylene crosslinking. The experimental results were confirmed by means of ir-, NMR spectra and by measuring the modules of the irradiated polyethylene. (auth)

26995 THERMAL DEGRADATION OF IRRADIATED POLYPROPYLENE. Veselovskii, R. A.; Leshchenko, S. S.; Karpov, V. L. (Karpov Physico-Chemical Inst., USSR). Vysokomol. Soedin., 8: 744-8(Apr. 1966). (In Russian).

The rates of gas evolution during thermal degradation of irradiated isotactic and atactic polypropylene were studied. The rate of degradation of crosslinked polypropylene was higher than for the linear one. On the basis of the analysis of gas evolution curves, it was concluded that isotactic polypropylene at temperatures above 350°C in vacuo undergoes random degradation with the exception of the initial stage of pyrolysis. The rate of degradation was higher in the presence of active oxygen-containing groups. These groups are spent at irradiation and near the dose of gel-point the pyrolysis of isotactic polypropylene procedes on random mechanism. This also indicates the absence of structuration in polypropylene chains at irradiation up to gel formation dose. Pyrolysis curves of atactic polypropylene proved that it is a branched polymer. (auth)

26996 RADIATION STABILITY OF ISOMERIC AROMATIC POLYAMIDES. Fomenko, A. S.; Krasnov, E. P.; Abramova, T. M.; Dar'eva, E. P.; Furman, E. G.; Galina, A. A. Vysokomol. Soedin., 8: 770(Apr. 1966). (In Russian).

The integral dose required for accumulation of 1×10^{14} radicals at γ irradiation of aromatic polyamides was found to be of an order higher than that for aliphatic polyamides. The radiation yields of hydrogen were two orders lower than for aliphatic polyamides. There were no changes in ir-spectra and thermomechanical properties of the aromatic polyamides γ irradiated in vacuo and in the presence of oxygen samples. This proves the high radiation stability of aromatic polyamides. (auth)

26997 RELAXATION TIMES OF ELECTRON SPINS OF RADICALS IN SOME IRRADIATED AMINO ACIDS AT 4.2 DEG K. Buerk, G.; Schoffa, G. (Technische Hochschule, Karlsruhe, Ger.). Z. Naturforsch., 21a: 296-300 (Mar. 1966). (In German).

Electron spin relaxation times of the irradiated amino acids acetylvaline, sarcosine, betaine, and glycine were measured at 4.2°K by two different methods. From the exponential decrease of signals due to saturation after rapid adjustment of the ESR spectrometer on resonance, the following spin-lattice relaxation times were measured: acetylvaline $T_1 = 0.2$ sec, sarcosine $T_1 = 0.14$ sec, betaine $T_1 = 0.07$ sec, glycine $T_1 \sim 0.3$ sec. By the Portis saturation method the product T_1T_2 was measured, and, T_1 being known, the following spin-spin relaxation times T_2 were obtained: acetylvaline 2.1×10^{-9} sec, sarcosine 1×10^{-9} sec, betaine 9×10^{-10} sec. All measured amino acids showed the saturation behavior of substances with inhomogeneous line broadening. (auth)

26998 RADIATION RESISTANCE OF ION-EXCHANGE RESINS. Skorokhod, O. R.; Ovsyanko, L. M. (Belorussian State Univ., USSR). Zh. Fiz. Khim., 39: 2553-8(Oct. 1965). (In Russian).

A study was made of the effect of γ radiation from ^{60}Co on the sorption capacity of a sulfonated styrene-divinylbenzene copolymer (KU-2 cation exchange) with respect to benzoic acid, aniline, and pyridine. The samples of KU-2 were washed with hydrochloric acid and distilled water and then exposed to γ radiation from ^{60}Co at 150 R/sec at 17 to 20°C in sealed ampules filled with the corresponding medium. After irradiation, the ion-exchanger was washed with water and dried. KU-2 subjected to γ radiation at an integrated dose of 1.1×10^4 darkened, but did not suffer noticeable changes in properties. Its exchange capacity and swelling in water remained the same. A study of sorption kinetics under static conditions and the isothermic curves of the sorption of benzoic acid, aniline, and pyridine showed that irradiation with a dose of 10^4 R hardly affected the sorption properties of KU-2 with respect to these substances. The breaking of C–S and the main C–C bonds occurred during irradiation of KU-2 in the H form with an integrated dose of 10^8 R. This caused a decrease in the exchange capacity of SO_3H-groups and increased swelling in water. The effect was much stronger when the irradiation was made in water and aqueous solutions of nitric acid instead of air. The γ-irradiation had a different effect on sorption capacity with respect to benzoic acids, aniline, and pyridine. The sorption of benzoic acids on irradiated samples increased, while that of pyridine and aniline decreased after irradiation. The sorption of aniline and pyridine changed symbatically with changes in the concentration of sulfo groups in KU-2. In all cases studied the pyridine was sorbed in larger quantities than aniline. The sorption of benzoic acid increased with decreasing temperature. (CFSTI)

26999 THE REACTION OF ISOPROPYLBENZENE ON γ-IRRADIATED SILICA-ALUMINA: THE EFFECT OF ANNEALING AND OF EXPOSURE TO HYDROGEN OR OXYGEN. Hentz, Robert R.; Perkey, Lewis M.; Williams, Robert H. (Socony Mobil Oil Co., Inc., Princeton, N. J.). 13p. (CONF-651052-1). ORAU. Gmelin, AED-CONF-65-283-1.

From Indiana Academy of Sciences, 81st Annual Meeting, Notre Dame, Ind.

Annealing experiments performed on γ-irradiated alumina–silica indicated that the radioinduced excitations that cause dealkylation of isopropylbenzene can be thermally deactivated. More than one group of excitations were found to be present in the irradiated alumina–silica. Those excitations annealing between 77 and 115°C correlated with visible color centers that are thermally bleached. Certain of the excitations, not absorbing in the visible, were not annealed even at 300°C. Exposure of the irradiated solid to hydrogen resulted in bleaching of the visible color centers, irreversible adsorption of hydrogen, and elimination of a portion of the excitations that are effective in dealkylation of isopropylbenzene. Expressed as molecules per gram of solid, the amount of hydrogen adsorbed was slightly greater than the reduction in benzene yield. The reduction in benzene was also approximately equal to the number of excitations annealed in the lowest temperature range, 77 to 115°C. Oxygen had no effect on the visible color or the benzene yield. The excitations annealing at 77°C were identified tentatively with the visible color centers believed to be associated with positive holes trapped at substitutional aluminum. The likelihood that visible color centers are distributed uniformly throughout the solid suggested that these excitations may be transferred over distances up to 50 to 100 Å. The radioinduced dealkylation activity was found to decrease with age of the unirradiated solid. However, only the precursors of the excitations annealing at 77°C were affected. (auth)

Radiochemistry

See also Separation Processes and Procedures

Refer also to abstract 27283.

27000 (CONF-651111) RADIOACTIVE PHARMACEUTICALS. Proceedings of a Symposium Held at the Oak Ridge Institute of Nuclear Studies, Tennessee, November 1–4, 1965. 6th AEC Symposium Series. Andrews,

Gould A.; Kniseley, Ralph M. (Oak Ridge Inst. of Nuclear Studies, Inc., Tenn.); Wagner, Henry N. Jr. (eds.) (Johns Hopkins Medical Institutions, Baltimore, Md.). Apr. 1966. Contract AT(40-1)-Gen-33. 702p. Dep. mn. CFSTI $5.00 cy, $3.00 mn.

Forty-five articles on recent advances in the development of radioactive pharmaceuticals for use in clinical medicine and biological research are included; separate abstracts were prepared for each. (P.C.H.)

For abstracts of individual chapters see: 26594, 26630–26636, 26707, 26713–26717, 26729–26737, 26903, 27016–27032, 27068, and 27396–27398.

27001 (INR-675/XIII/J) PREPARATION OF POTASSIUM CYANIDE-^{14}C BY THE ISOTOPIC EXCHANGE METHOD. Wolska-Witerowa, Maria (Institute of Nuclear Research, Warsaw (Poland)). Dec. 1965. 15p. Dep.

Optimum conditions for the isotopic exchange of carbon atoms between barium carbonate–^{14}C and nonradioactive potassium cyanide were worked out. The exchange degree was 100% and the chemical yield was 95% based on the potassium cyanide used. The purity of obtained potassium cyanide was 96%. (auth)

27002 (INR-676/XIII/J) PREPARATION OF ^{14}C-LABELED CARBOXYLIC ACIDS BY THE ISOTOPIC EXCHANGE METHOD. Wolska-Witerowa, Maria (Institute of Nuclear Research, Warsaw (Poland)). Dec. 1965. 8p. Dep. mn.

A new method for the preparation of anhydrous formic acid–^{14}C, acetic acid-1–^{14}C, and propionic acid-1–^{14}C by isotopic exchange of acid anions was developed. The method consists of two steps: isotopic exchange reaction; and separation of the products after the reduction has been completed. (P.C.H.)

27003 PREPARATION OF ^{239}Np TRACER. Sill, Claude W. (Atomic Energy Commission, Idaho Falls, Idaho). Anal. Chem., 38: 802-4(May 1966).

The procedures for separating ^{239}Np from ^{243}Am and from irradiated U in acid solutions by solvent extraction using triisooctylamine in xylene are described. The recoveries of ^{239}Np from Am and irradiated U were ~98 and 95%, respectively. The radiochemical purity of the Np tracer obtained was determined by comparing the gamma spectra of the Am and Np fractions with the spectrum of an equilibrium mixture. (F.J.H.)

27004 VACUUM EVAPORATING SYSTEM WITH INDUCTIVE HEATING TO EVAPORATE RADIOACTIVE METALS AND METAL OXIDES. Fiedler, W.; Grass, F.; Harms, J. (Oesterreichische Hochschule, Vienna). Atomkernenergie, 11: 257-8(May-June 1966). (In German).

A high-vacuum evaporating system with inductive heating is described. This system performs the evaporation of any nuclide, even one with an extremely high evaporating point, such as UO_2, PuO_2, and W. The evaporating container is made of quartz glass. Because of its small size and easy dismounting, the container can be filled and decontaminated inside a glove box. Therefore the main part of the evaporated substance can be recovered from the inside walls of the container if necessary. (auth)

27005 PLUTONIUM LABORATORIES OF THE ADMINISTRATION OF CHEMISTRY AND ISOTOPES OF THE J.E.N. Sanchez, F. Ruiz (Junta de Energia Nuclear, Madrid). Energ. Nucl. (Madrid), 10: 4-19(Jan.-Feb. 1966). (In Spanish).

The operational and protective measures taken to ensure the safety of workers in hot laboratories are reviewed. The plutonium laboratory of the J.E.N. is described and shown schematically. The utility circuits are outlined. The hot cells and their equipment are described. (J.S.R.)

27006 CHEMICAL EFFECTS ASSOCIATED WITH NUCLEAR REACTIONS. APPLICATION OF THE SZILARD-CHALMERS EFFECT TO THE PREPARATION OF ^{51}Cr OF HIGH SPECIFIC ACTIVITY. Abellan, Jose Ortega (Junta de Energia Nuclear, Madrid). Energ. Nucl. (Madrid), 10: 41-7(Jan.-Feb. 1966). (In Spanish).

An explanation is given of the Szilard-Chalmers process with emphasis on its chemical aspects. The Szilard-Chalmers effect was applied experimentally to the preparation of high-specific-activity ^{51}Cr. The effects of different variables (type of chromate irradiated, position and irradiation time of potassium chromate, physical treatment of the irradiated samples, and chemical treatment) on the specific activities obtainable were studied. (J.S.R.)

27007 RADIOSULFUR-EXCHANGE REACTIONS IN LIQUID HYDROGEN SULFIDE. I. Mickelsen, J. R.; Norris, T. H.; Smith, R. C. (Oregon State Univ., Corvallis). Contract AT(45-1)-244. Inorg. Chem., 5: 911-16 (May 1966). (RLO-244-1).

Sulfur-35 was used to study a number of solute-solvent exchange reactions in the solvent liquid hydrogen sulfide. In neutral solution the exchange rate was negligible or exceedingly slow with sulfur, carbon disulfide, dimethyl sulfide, or ethyl mercaptan. In basic, triethylamine-containing solutions, however, arsenic and antimony tri- and pentasulfides, carbon disulfide, and sulfur all showed rapid exchange; phosphorus pentasulfide gave a moderate rate (apparently related to slow attainment of equilibrium among solute species), while ethyl mercaptan again showed no significant exchange. The results were interpreted as generally supporting the concept of the formation of thio anionic species in the basic solutions in those cases where moderate to fast exchange occurs. (auth)

27008 RADIOSULFUR-EXCHANGE REACTIONS IN LIQUID HYDROGEN SULFIDE. II. KINETICS OF THE CARBON DISULFIDE-SOLVENT EXCHANGE IN TRIETHYLAMINE-CONTAINING SOLUTIONS. Mickelsen, J. Jr.; Norris, T. H. (Oregon State Univ., Corvallis). Contract AT(45-1)-244. Inorg. Chem., 5: 917-21(May 1966). (RLO-244-2).

The kinetics of radiosulfur exchange between carbon disulfide and the solvent liquid hydrogen sulfide in solutions containing triethylamine was studied. Convenient half-times occur at −23°C. The results are interpreted in terms of thiocarbonate formation in the solutions. Two alternative models fit the results about equally well. One postulates a relatively complete solute-solvent reaction yielding the substance $((C_2H_5)_3NH)(HC_2S_5)$, the exchange being first order in this species. The second model assumes formation at low triethylamine concentrations of an acid thiocarbonate, $((C_2H_5)_3NH)(HCS_3)$, this substance tending toward conversion to the normal form, $((C_2H_5)_3NH)_2CS_3$, at higher amine concentrations, and the exchange rate being first order in the acid form and independent (or nearly so) of the concentration of the normal form. In either case, thiocarbonate dissociation is taken to be the rate step. Equilibrium and rate constants were obtained in terms of both models. The first, with negligible dissociation of $((C_2H_5)_3NH)(HC_2S_5)$ assumed, yields the activation parameters $\Delta H^* = 19.0$ kcal/mole and $\Delta S^* = 2.0$ eu. (auth)

27009 PREPARATION OF THIN UNIFORM TARGETS OF ACTINIDE ELEMENTS: URANIUM AND AMERICIUM. Laul, J. C.; Ramaniah, M. V.; Rao, C. L. (Atomic Energy Establishment, Bombay). Int. J. Appl. Radiat. Isotop., 17: 306-8(May 1966).

Preparation of uniform sources of americium and uranium on aluminum, copper, platinum, and stainless steel backings for use in fission studies is described. Electrodeposition was carried out on metal cathodes, 1.5 to 5.0 cm^2 in area. To get uniform coating, the anode was kept rotating at about 200 rpm. Uranium solutions were prepared using pure uranyl nitrate. Americium solutions were prepared using milligram quantities of ^{241}Am. The pH adjustments were made using ammonium hydroxide and the appropriate acids. (F.J.H.)

27010 HOT-ATOM AND THERMAL REACTIONS OF FISSION-PRODUCT RUTHENIUM IN ORGANIC SOLVENTS. Zahn, U.; Harbottle, G. (Brookhaven National Lab., Upton, N. Y.). J. Inorg. Nucl. Chem., 28: 925-31(Apr. 1966). (BNL-9350).

When ^{103}Ru atoms are introduced into organic solvents via fission recoil and β decay (of precursors of mass 103) in certain cases small yields of volatile, ruthenium-

labeled organic molecules are obtained. However, when the solvent is monomeric cyclopentadiene, a thermal reaction transforms virtually all of the ruthenium into the "sandwich" compound ruthenocene. When separated fission product $^{106}RuCl_3$ is mixed with cyclopentadiene in a test-tube, labeled carrier-free ruthenocene is also obtained by what seems to be the same thermal reaction. (auth)

27011 PREPARATION OF TRITIUM-LABELED COMPOUNDS. I. SERIES OF SULFONYLUREA HYPOGLYCEMIC AGENTS BY EXCHANGE WITH TRITIUM GAS. Thomas, Richard C.; Ikeda, George J. (Upjohn Co., Kalamazoo, Mich.). J. Pharm. Sci., 55: 112-14(Jan. 1966).

Seven tritium-labeled sulfonylurea hypoglycemic agents were prepared by the tritium-gas exposure method. The tritium-gas exchange method of Wilzbach was chosen because of the relatively low cost of tritium gas and the need for labeling a large number of sulfonylureas, not all of which would necessarily prove of sufficient clinical interest for continued study. The sodium salts of the sulfonylureas were prepared by adding a molar equivalent of 1 N aqueous sodium hydroxide solution and lyophilizing to obtain a finely divided solid suitable for exposure to tritium gas. The samples were exposed to carrier-free tritium gas under various conditions. Following exposure to tritium gas, each crude sample was precipitated from alkaline solution by addition of a slight excess of acid and then filtered and washed with water. This procedure was carried out 3 times to remove labile tritium completely. During one of the precipitations, the alkaline solution was treated with activated charcoal. The sulfonylureas were more satisfactorily labeled with tritium by exposure of their sodium salts, rather than the free compounds, to tritium gas. The sodium salts incorporated 5 times as much stably bound tritium on the average as did the free sulfonylureas. It is possible that in the case of the free sulfonylureas the tritium tends to localize at the labile —NH— position, diluting the tritium gas with hydrogen and thereby decreasing the rate of exchange of tritium with the more stable hydrogens. (BBB)

27012 RADIOISOTOPE LABORATORY. Motojima, Kenji; Omura, Michio (Japan Atomic Energy Research Inst., Tokyo). Kagaku To Kogyo (Tokyo), 16: 219-23 (Feb. 1963). (In Japanese).

Several problems are considered in the design of the radioisotope lab: protection of personnel from radioactivity, radioactive contamination of floor and walls, control of radioactive contamination in the air, treatment of contaminated water, and security of radioactivity sources in case of fire. Ventilation, water supply, and waste disposal for the lab are also considered. Lead or concrete shields should be used for protection from large sources of radioactivity. For the floor, wall, ceiling, and working surfaces of the lab which are likely to be contaminated with radiation sources, special materials should be used to decrease the degree of contamination, such as use of disposable vinyl or polyethylene sheets to protect the surfaces of working areas. The air from the room can be exhausted and filtered to lower the radioactivity concentration in the air. The disposal of radioactive waste solutions should be separate from the general drainage system. Highly concentrated solutions can be collected in a storage tank or diluted to allowable concentrations with water and discarded. A radioisotope contamination detection room should include cleansing equipment, a dressing area, and equipment for detecting contamination. (BBB)

27013 USE OF SUBLIMATIVE SEPARATION METHOD FOR OBTAINING CARRIER-POOR ^{51}Cr, ^{99}Mo, ^{187}W, AND ^{99m}Tc. Reichold, P.; Anders, H. P. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Radiochim. Acta, 5: 44-8(Mar. 1966). (In German).

The possibility of separating nuclides produced by (n,γ) reactions in neutron irradiated chromium, molybdenum, or tungsten carbonyl from the carrier by sublimation of the activated compounds was investigated. ^{51}Cr can be enriched by this method. The sublimation of neutron-activated molybdenum hexacarbonyl leaves ^{99}Mo partially in the sublimate. The labeled compound can be used to obtain technetium, as the ^{99m}Tc produced by β decay remains, as a largely molybdenum free "activity residue," after another sublimation on the bottom of the sublimation-vessel. (auth)

27014 FORMATION OF FLUORINE-CONTAINING COMPOUNDS OF XENON DURING β DECAY OF ^{131}I CONTAINED IN IODINE PENTAFLUORIDE. Murin, A. N.; Nefedov, V. D.; Kirin, I. S.; Leonov, V. V.; Zaitsev, V. M.; Akulov, G. P. Radiokhimiya, 7: 629-30(1965). (In Russian).

Free ^{131}Xe was accumulated by bubbling helium for 8 hr at room temperature through liquid $^{131}IF_5$. The origin of this free ^{131}Xe was traced to the intermediate formation of a molecular ion $[^{131}XeF_5]^+$. After removal of free ^{131}Xe, the β-decaying material was hydrolyzed and the products of hydrolysis were subjected to reduction with various reducing agents. In the course of treatment with HCl the xenon fluorine compounds were reduced to free xenon. No free xenon was obtained when KI, hydroxylamine, or Fe^{2+} were used as reducing agents. It was found that the xenon fluorine compounds are more volatile than the starting $^{131}IF_5$. (ATD)

27015 FORMATION OF OXYGEN-XENON COMPOUNDS DURING β-RADIATION OF ^{133}I INCORPORATED IN POTASSIUM PERIODIDE. Murin, A. N.; Nefedov, V. D.; Kirin, I. S.; Grachev, S. A.; Gusev, Yu. K.; Saikov, Yu. P. Radiokhimiya, 7: 631-2(1965). (In Russian).

Xenon oxides (XeO_4 and XeO_3) were prepared by β decay of ^{133}I in potassium periodide. Helium gas was bubbled for 30 min at a rate of 26 ml/min through a solution of $K^{133}IO_4$ and $K^{133}I$ in 0.002 normal H_2SO_4 to remove free xenon. The elemental iodine was removed from the gas stream by passing helium through a KOH-absorber. The xenon oxides were trapped on AG-5 activated carbon at liquid nitrogen temperature. The quantity of trapped ^{133}Xe was measured using an AI-100-1 analyzer. It was found that XeO_4 is unstable in acidic media and decomposes to XeO_3. (ATD)

27016 CHARACTERISTICS OF AN IDEAL RADIOPHARMACEUTICAL. Wagner, Henry N. Jr.; Emmons, Hamilton (Johns Hopkins Medical Institutions, Baltimore). pp 1-32 of CONF-651111.

A radiopharmaceutical can be characterized by four major parameters: its time-course within the organ or lesion under study relative to other structures of the body; its type and rate of radioactive decay; its detection characteristics; and its production factors. The steps in the design or selection of a radiopharmaceutical are outlined as follows: establish that the biomedical problem requires one of several possible radiopharmaceuticals; establish the maximum permissible radiation dose; determine the time-course of each radiopharmaceutical in the target and nontarget areas; determine the optimum time at which measurements should be made, using an optimizing figure of merit; determine the dose of each radiopharmaceutical that can be administered up to the maximum permissible dose or to the level that provides adequate information; calculate a figure of merit for each radiopharmaceutical, based on an ideal detection system; modify the figure of merit for the type of radioactive decay, the detection parameters, and the production factors for each radiopharmaceutical; and choose the radiopharmaceutical that best meets all criteria. (auth)

27017 PROBLEMS CHARACTERISTIC OF RADIOACTIVE PHARMACEUTICALS. Charlton, J. C. (Radiochemical Centre, Amersham, Eng.). pp 33-50 of CONF-651111.

Certain well-defined requirements that determine the selection of isotopes, such as suitability of half life, physical properties, and availability in a chemical form that will have the desired biological behavior are discussed. Special problems in assuring sterility and freedom from pyrogens, particularly for preparations of radionuclides of short half life are described. (P.C.H.)

27018 BIOCHEMICAL VIEW OF RADIOPHARMACEUTICAL DEVELOPMENTS. Bayly, Russell J. (Radio-

chemical Centre, Amersham, Eng.). pp 51-66 of CONF-651111.

With a radiopharmaceutical defined as including compounds used in vitro as well as those used in vivo, the role of labeled compounds in medical diagnosis is considered according to how they are used: to physically trace the compound in vivo when isotopes aid the procedure and when isotopes are essential for the procedure; to biochemically trace the compound in vitro; and for the assay of biochemicals from body fluids or tissues. Examples of each category illustrate potentially important methods that should be more widely applied. Some relevant aspects of the purity and stability of labeled compounds are briefly discussed. (P.C.H.)

27019 CHEMICAL AND RADIOCHEMICAL PURITY OF RADIOACTIVE PHARMACEUTICALS RELATED TO THEIR BIOLOGICAL BEHAVIOR. Cohen, Yves (CEN, Saclay, France. Univ., Paris). pp 67-91 of CONF-651111.

Equipment and methods used to evaluate the chemical and radiochemical purity of inorganic, organic, and biological radiopharmaceuticals are described. The phenomena linking the radiochemical purity to the biological properties of these products and to the determination of their distribution in living organisms are discussed along with the value of these methods and the factors that must be considered in choosing the norms that have to be fixed when the specifications are drawn up. (auth)

27020 QUALITY CONTROL, PYROGEN TESTING, AND STERILIZATION OF RADIOACTIVE PHARMACEUTICALS. Briner, William H. (National Institutes of Health, Bethesda, Md.). pp 93-111 of CONF-651111.

Control tests routinely used when radiochemicals are involved in the formulation of radiopharmaceuticals because radiochemical suppliers are unable to make any warranty concerning the pharmaceutical or medicinal quality of such materials are discussed. These methods are also frequently of value as a double check on commercially available radiopharmaceuticals. Proper attention to the cleaning and storage of glassware, equipment, and reagents, use of the highest available quality of chemicals and reagents, and the employment of acceptable aseptic techniques in the formulation procedure are stressed. Sterilization of radiopharmaceutical products with a membrane filter is suggested as the method of choice for true solutions as well as for many colloids. Saturated steam under pressure in an autoclave is also an excellent sterilization method for compounds that will withstand the physical conditions of this method. Pyrogen and sterility test methods detailed in the United States Pharmacopeia are discussed. Examples of forms used by the National Institutes of Health for recording data concerning a given dose or product, including biological test results, assay, specific activity, and others, are illustrated. (auth)

27021 RADIOACTIVE PHARMACEUTICALS AND THE CONCEPT OF STABILITY. Glenn, Howard J.; Kidwell, Ralph E. (Abbott Labs., Chicago). pp 165-75 of CONF-651111.

Methods for studying stability of radioactive pharmaceuticals and information gained from such studies are discussed. Primarily information on breakdown and formulation is obtained. (P.C.H.)

27022 PRACTICAL ASPECTS OF THE PRODUCTION AND SUPPLY OF RADIOPHARMACEUTICALS. Volk, Murray E. pp 177-80 of CONF-651111.

The development and standards in the radiopharmaceutical industry are discussed with special consideration given to the production and problems involved in the supply and distribution of short lived products. (P.C.H.)

27023 RADIOISOTOPE-LABELED COMPOUNDS AS DRUGS. Numerof, Paul (E. R. Squibb and Sons, New York). pp 181-4 of CONF-651111.

Techniques used to test for assurance of sterility and freedom from pyrogenicity in a pharmaceutical preparation are described. The need for extending to radioactive pharmaceuticals the same concepts of manufacturing practice that apply to nonradioactive pharmaceutical products is stressed. (P.C.H.)

27024 SUPPLYING THE NEW SHORT-LIVED RADIOPHARMACEUTICALS. Konneker, W. R. (Nuclear Consultants Corp., St. Louis). pp 185-9 of CONF-651111.

The problems in producing short-lived radiopharmaceuticals are listed, and suggestions are made for overcoming the problems. The most practical solutions seem to be the development by the commercial suppliers of more distribution laboratories throughout the U. S. and the use of radionuclide generators. (P.C.H.)

27025 IODINATION OF PROTEIN COMPOUNDS. Hunter, W. M. (Medical Research Council, Edinburgh). pp 245-64 of CONF-651111.

A brief historical review describes the need and methods for preparations of ^{131}I proteins of high specific activity (100 to 300 $\mu C/\mu g$) for use in radioimmunoassay procedures. The extent to which gastrin 1, human growth hormone (HGH), and bovine plasma albumin can be substituted with ^{127}I by the chloramine-T method is described, as well as the effect of iodination with ^{127}I on the immunological activity of HGH. High-specific-activity (200 to 300 $\mu C/\mu g$) preparations of ^{131}I-HGH have, since early 1964, sometimes shown damage, and this is shown to be caused by some noxious substance(s) present in some batches of $Na^{131}I$. The use of ^{125}I-HGH of 40 to 90 $\mu C/\mu g$ provides a possible alternative. Methods of testing for loss of immunological integrity of radioiodinated HGH are described, and a method using Sephadex G200 columns in borate at pH 8.6, which is capable of removing a grossly damaged component is given. The importance of immunologically intact preparations for radioimmunoassays aimed at the highest possible sensitivity is emphasized. (P.C.H.)

27026 PREPARATION OF HIGH-SPECIFIC-ACTIVITY ^{131}I-LABELED HORMONES: USE IN RADIOIMMUNOASSAY OF HORMONES IN PLASMA. Yalow, Rosalyn S.; Berson, Solomon A. (Veterans Administration Hospital, Bronx, N. Y.). pp 265-80 of CONF-651111.

The preparation and purification of ^{131}I-labeled hormones at specific activities in the range 500 to 1200 mC of ^{131}I per milligram of protein are described. The specific-activity requirements for the use of ^{131}I-labeled hormones in the radioimmunoassay of plasma hormone concentrations and the theoretical and practical limitations in achieving the optimum specific activity were considered for several hormones. Procedures for minimizing damage to the labeled hormones during preparation and purification and during incubation with plasma are discussed, and measures for increasing sensitivity of radioimmunoassay are suggested. (auth)

27027 SPECIAL IODINATED COMPOUNDS FOR BIOLOGY AND MEDICINE. Tubis, Manuel (Veterans Administration Center, Los Angeles. Univ. of California Center for the Health Sciences, Los Angeles). pp 281-304 of CONF-651111.

Basic principles of radioiodination by direct combination and by exchange as applied to some special compounds are reviewed. These are cited as type reactions which may suggest techniques applicable to radioiodine and other radionuclides. The design of specific compounds based on tissue or organ specificity is described. The criteria of purity, identity, and suitability for special purposes are also reviewed. (P.C.H.)

27028 ^{99m}Tc-ALBUMIN. Stern, Howard S.; McAfee, John G.; Zolle, Ilse (Johns Hopkins Medical Institutions, Baltimore). pp 359-82 of CONF-651111.

A method for the preparation of ^{99m}Tc-serum albumin is described. A labeling efficiency of greater than 90% is obtained by adding acid-reduced pertechnetate ($^{99m}TcO_4^-$) to a 5% serum albumin solution buffered at approximately pH 6.0. Under the conditions used, both iron and ascorbic acid were found to be necessary for binding to occur. The unbound or free ^{99m}Tc is effectively removed by an anion-exchange-resin column. The binding of ^{99m}Tc to albumin is analyzed by descending paper chromatography in 85% methanol. The parameters of the labeling process are discussed, and a complete procedure on the preparation of ^{99m}Tc-albumin for clinical use is described. A comparison was made between ^{99m}Tc-albumin and ^{131}I-albumin with respect to the loss of radioactivity from the blood and the

accumulation in various organs. Some representative placental and cardiac scans are shown which delineate the blood pool in these organs. Preliminary data are discussed with respect to the labeling of macroaggregated albumin with ^{99m}Tc. An alkaline reduction followed by heating in the presence of albumin showed ^{99m}Tc binding to MAA of the order of 30%. Intravenous injection of this material into a dog allowed direct visualization of the lungs. (auth)

27029 RED-CELL LABELING AGENTS. Berlin, Nathaniel I. (National Institutes of Health, Bethesda, Md.). pp 447-54 of CONF-651111.

The preparation and use of labeled red cells are discussed. Problems inherent in determining the selection of the isotope, include physical half life, elution of label from intact cells, measurement technique, and an estimate of radiation dose. Reuse of the label after catabolism of the red cell is a problem only with radioiron-labeled cells. No other labels are reused. (P.C.H.)

27030 PRODUCTION AND METABOLISM OF COBALT-LABELED CYANOCOBALAMIN. Rosenblum, Charles (Merck, Sharp and Dohme Research Labs., Rahway, N. J.). pp 455-76 of CONF-651111.

The labeling of cyanocobalamin with radioactive isotopes is discussed. Metabolic studies performed with radioactive vitamin B_{12} are reviewed under the following four categories: absorption; distribution pattern; retention and turnover; and metabolic products. (71 references). (auth)

27031 SYNTHESIS AND PURITY OF LABELED LIPIDS. Snyder, Fred (Oak Ridge Inst. of Nuclear Studies, Tenn.); Piantadosi, Claude. pp 553-65 of CONF-651111.

Thin-layer chromatographic and gas–liquid chromatographic procedures for radioassay of lipids are reviewed. General procedures for the preparation of labeled lipids (^{131}I, ^{125}I, ^{38}Cl, ^{14}C, and ^{3}H) include biosynthesis, exchange reactions, and organic syntheses; examples of those procedures described in the literature are given. Responsibilities in establishing specifications and control of radiopurity of lipids are stressed. (auth)

27032 ^{18}F: PRODUCTION BY NEUTRON ACTIVATION AND PHARMACOLOGY. Dworkin, Howard J.; LaFleur, Philip D. (Univ. of Michigan, Ann Arbor). pp 635-48 of CONF-651111.

A method of producing sterile carrier-free ^{18}F ($t_{\frac{1}{2}}$, 110 min) by thermal-neutron bombardment of ^{6}Li as the carbonate is presented. Purification involves precipitation on lanthanum hydroxide followed by ion exchange. The contaminating ^{3}H is thus reduced to less than 0.05 μC per microcurie of ^{18}F, and ^{24}Na is reduced to less than 0.025%. The final product contains about 229 μC of ^{18}F per milliliter. The Na^{18}F was used to study excretion, blood disappearance, tissue distribution, and bone uptake in man and in the dog. The dog excretes 50% of the given dose within 6 hr. By 6 hr 5% of the dose remains in the blood pool. Similar results were found in man. Tissue distribution studies indicate that bone concentrates 2 to 10 times more ^{18}F than soft tissues in the dog and 10 to 20 times more than soft tissues in man. Bone tumors concentrated 3.5 to 10 times as much ^{18}F as normal bone. The nonhomogeneous distribution of ^{18}F in bone is autoradiographically presented, and some of the biologic factors involved in estimation of the radiation dose to bone are discussed. (auth)

Separation Processes and Procedures

See also Analytical Procedures
ISOTOPE TECHNOLOGY — Separation and Production

Refer also to abstracts 27201, 27476, and 28828.

27033 (BNL–10182) INVESTIGATIONS AND APPLICATIONS OF THE CHEMICAL EFFECTS OF NUCLEAR TRANSFORMATIONS. I. TELLURIUM ISOMER GENERATORS. Hillman, Manny; Weiss, Allen J. (Brookhaven National Lab., Upton, N. Y.). Apr. 28, 1966. Contract AT(30-2)-Gen-8. 25p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

The possibility of preparing an isomer generator based on the chemical and nuclear transformations of ^{129g}Te(IV) yields from ^{129g}Te(VI) was investigated. The ion exchange behavior of Te(VI) on alumina was also studied. The results showed that Te(IV) can be adsorbed on alumina between pH 0 and 10 and can be eluted in greater than 95% yield by a solution, the pH of which lies outside this range. Alumina was used to prepare isomer generators in which the ^{129g}Te was allowed to grow in at various pH's. The milking yields obtained are listed. (P.C.H.)

27034 (EURAEC–1479) REGENERATION OF CERAMIC FUELS. Final Report No. 3. Schmets, J.; Camozzo, G.; Francesconi, A.; Heremans, R.; Pierini, G.; Speeckaert, Ph. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). [1964]. Contract 098-62-11-RDB. 99p. (EUR–2399). Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Research on processing ceramic fuels revealed the importance of cycles based on the oxidation, hydrofluorination, and fluorination of UO_2 and PuO_2. The tests were effected in fluid beds using up to 4 kg of UO_2. The volatilization of UCl_6 is practically quantitative. Thermogravimetric tests conducted at the same time showed that it is possible to separate U and Pu when fluorination is effected using ClF_3. In this process, the Pu residue is converted to hexafluoride using F_2 and is separated from most fission products. Research on conversion of U fluorides to dioxide in molten salt media revealed parameters which govern the production of stoichiometric UO_2. The separation of U and Pu and conversion of the latter to dioxide by the same technique were also investigated. Activation energy values (kcal/mol) were established for air roasting of $UO_3\Sigma$ into U_3O_{14} : N17; He roasting of $UO_3\Sigma$ into U_3O_{14} : N21; reduction of U_3O_8 by H_2 : N22; reduction of U_3O_8 by ammonia : N32; and hydrofluorination of $UO_3\Sigma$: N5.5. (J.R.D.)

27035 (IDO–14661) CHEMICAL AND PROCESS DEVELOPMENT BRANCH ANNUAL REPORT, FISCAL YEAR 1965. Bower, J. R. (ed.) (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Feb. 1966. Contract AT(10-1)-205. 115p. Dep. mn. CFSTI $4.00 cy, $0.75 mn.

Developmental activities are reported in three sections. Separate abstracts were prepared for each section. (J.R.D.)

For abstracts of individual sections see: 27036, 28833, and 28853.

27036 (IDO–14661, pp 1-44) FUEL REPROCESSING. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.).

Progress is reported on processing of fuel alloys based on Al, Zr, and stainless steel. In process-associated work, dissolution of Si-rich Al alloy fuels was investigated, and Zr processing studies were conducted. Testing and production of diabasic aluminum nitrate for extraction use are described along with TBP-Amsco recovery washing process and development of air pulsers and controllers. Reprocessing of EBR fuel is reported, and studies of graphite fuel processing and electrolytic dissolution are discussed. (J.R.D.)

27037 (JAERI–1106) DATA OF INORGANIC SOLVENT EXTRACTION. [PART] 3. Ishimori, T.; Akatsu, E.; Tsukuechi, K.; Kobune, T.; Usuba, Y.; Kimura, K.; Onawa, G.; Uchiyama, H. (Japan Atomic Energy Research Inst., Tokyo). Jan. 1966. 31p. Dep. mn.

The solvent extraction behavior of about fifty chemical elements was studied in the following solvent extraction systems: diethyl cellosolve-NH_4NO_3; pentaether-NH_4NO_3, di-isopropyl ketone-HCl; hexone-HCl; hexone-HNO_3; and isopropyl ether-HCl. The acidity dependence was radiochemically determined in each system. Supplementary data are given for the systems TBP-H_2SO_4 and Primene JM-T-HNO_3 system. (P.C.H.)

27038 (K–1666) REMOVAL OF IMPURITIES FROM URANIUM HEXAFLUORIDE BY SELECTIVE SORPTION TECHNIQUES. Brater, D. C.; Kaufman, H. L.; Pashley, J. H.; Smiley, S. H. (Oak Ridge Gaseous Diffusion Plant, Tenn.). June 6, 1966. Contract W-7405-eng-26. 43p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

Results of investigations on the effectiveness of various solid sorbents in removing volatile impurities from uranium hexafluoride are described, and the future program is discussed. Purification of uranium hexafluoride produced from power reactor returns by passing the fluorinator outlet gases through solid sorbents, such as sodium fluoride, magnesium fluoride, calcium fluoride, etc., appears promising. High concentrations of niobium pentafluoride and ruthenium pentafluoride were reduced to less than 1 ppM using either sodium fluoride or magnesium fluoride. Removal of small quantities of titanium tetrafluoride also seems possible. Work with other impurities is planned. (auth)

27039 (NP–15946) RECENT RESEARCH AND DEVELOPMENT WORK IN ENEA COUNTRIES RELATED TO THE TREATMENT OF LOW AND INTERMEDIATE LEVEL WASTES. Lopez-Menchero, E. (European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium)). Dec. 1965. 50p. (ETR–176; CONF-651202–19). Dep. mn. CFSTI $3.00 cy, $0.50 mn.

From Symposium on Practices in the Treatment of Low and Intermediate Level Radioactive Waste, Vienna.

Methods are described for the separation of fission products from waste solutions. These include: inorganic and organic ion exchangers; solvent extraction; foam separation; electrodialysis; and miscellaneous methods. Studies on the treatment of solid wastes and decontamination of materials are also mentioned. (P.C.H.)

27040 (ORNL–3831) STATUS AND PROGRESS REPORT FOR THORIUM FUEL CYCLE DEVELOPMENT FOR PERIOD ENDING DECEMBER 31, 1964. Wymer, R. G.; Douglas, D. A. Jr. (comps.) (Oak Ridge National Lab., Tenn.). May 1966. Contract W-7405-eng-26. 206p. Dep. mn. CFSTI $6.00 cy, $1.25 mn.

Research progress is summarized on solvent extraction, sol-gel processes, and fuel rod fabrication. Design of the building for the Th–U fuel cycle facility is described along with preparation of thoria-base solids. Extensions of the sol-gel process are discussed along with radiation effects on ThO_2 fuels and pyrolytic carbon-coated ThO_2–UO_2 microspheres. Studies on vibratory compaction of fuels are reported, and oxide sintering is discussed along with Th metal fuel research and fueled graphite research. Summaries of research are presented on preparation of materials for advanced fuels, fission-gas release from thoria fuels, gas evolution from thoria–urania sol-gel material, and separation of Pa from irradiated Th salts. (J.R.D.)

27041 (ORNL–3952) EXPERIMENTAL SURVEY OF CLOSE-COUPLED PROCESSING METHODS FOR FUELS CONTAINING URANIUM AND THORIUM. Ferris, L. M. (Oak Ridge National Lab., Tenn.). June 1966. Contract W-7405-eng-26. 34p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

Several methods that appeared to offer possibilities in the close-coupled processing of fuels that contain uranium and thorium were cursorily evaluated. The main objective was to find a simple, preferably single-stage, method that would serve as an alternative to solvent extraction for the removal of fission products from solutions produced by dissolving fuels in nitric acid. Decontamination factors of at least 100 were required. The methods considered were ion exchange (both organic and inorganic exchangers), crystallization by freezing, and precipitation of uranium and thorium as their oxalates, peroxides, and hydroxides. None of the techniques tested appeared feasible as close-coupled processes because, in general, uranium and thorium losses were high and the decontamination factors were low (less than 40). The required recoveries and decontamination factors could probably be achieved by using several cycles of anion exchange; this approach, however, would not offer advantages over solvent extraction. (auth)

27042 MONTMORILLONITE EXCHANGE EQUILIBRIA WITH STRONTIUM–SODIUM–CESIUM. Eliason, J. R. (Battelle-Northwest, Richland, Wash.). Amer. Mineral., 51: 324-35(Mar.-Apr. 1966).

The ion exchange isotherms and the free-energy changes of −2278, − 331, and −4019 cal/mole for the cesium–sodium, strontium–sodium, and cesium–strontium systems, respectively, were determined for the Bayard, New Mexico montmorillonite. The ion exchange isotherm and the free-energy change of −2035 cal/mole for the cesium–sodium system on the Chambers, Arizona montmorillonite were determined for comparison with the Bayard, New Mexico montmorillonite. An increase in selectivity for cesium and strontium at high cesium and strontium loading was observed in the cesium–sodium and strontium–sodium systems. The selectivity increases were presumed to be related to changes in the c-axis spacings. (auth)

27043 LIQUID-LIQUID EXTRACTION OF ANIONIC AMERICIUM AND EUROPIUM COMPLEXES OF HYDROXYETHYLETHYLENEDIAMINETRIACETIC ACID AND DIETHYLENETRIAMINEPENTAACETIC ACID. Moore, Fletcher L. (Oak Ridge National Lab., Tenn.). Anal. Chem., 38: 905-6(June 1966). (ORNL–P–1999).

Liquid-liquid extractions of americium and europium diethylenetriaminepentaacetic acid (DTPA) and N-hydroxyethylethylenediaminetriacetic acid (HEDTA) complexes with 20% Aliquat 336-S-xylene as a function of pH are discussed and the results are shown. (F.J.H.)

27044 STUDIES OF THE SYNTHETIC INORGANIC ION EXCHANGER. V. THE SEPARATION OF ^{95}Zr AND ^{95}Nb BY MEANS OF A STANNIC PHOSPHATE CATION EXCHANGER. Sato, Akiko; Inoue, Yasushi; Suzuki, Shin (Tohoku Univ., Sendai). Bull. Chem. Soc. Jap., 39: 716-20(Apr. 1966).

To develop a method for the separation of ^{95}Zr and ^{95}Nb, various eluants were investigated and a sulfuric acid solution was found to be most suitable for this purpose. After the stannic phosphate exchanger column was conditioned with 1N nitric acid, the sample solution was passed through it to adsorb ^{95}Zr and ^{95}Nb. By using a 2N sulfuric acid solution and a 3N sulfuric acid–0.01N hydrofluoric acid solution as eluants, ^{95}Zr and ^{95}Nb, respectively, could be eluted. The separation was not quantitative, however, because of the unfavorable tailing of the elution curves. On the basis of these results, the possibility of the total radiochemical separation of a long-lived fission product and the mechanism of the adsorption of these ions are discussed. (auth)

27045 AQUEOUS REPROCESSING OF REACTOR FUEL. Awwal, M. A.; Carswell, D. J. (Univ. of New South Wales, Sydney). Chem. Rev., 66: 279-95(June 1966).

The various aqueous processing methods developed and used for reprocessing of reactor fuels are reviewed. The separation of fission products, plutonium, thorium, and uranium from aqueous solutions of chloric, nitric, and sulfuric acids at varying concentrations using alkyl phosphate and amine solvents is described. Other methods considered include: ion-exchange, precipitation, and other solvent extraction methods. (221 references). (F.J.H.)

27046 SEPARATION OF RARE EARTH ELEMENTS BY RELATIVE SOLUBILITY OF THEIR CARBONATES IN CARBON DIOXIDE. Trombe, F.; Caro, P. (Centre National de la Recherche Scientifique, Bellevue (S. and O.), France). pp 87-98 of Chemistry Session C. Book Three [of Preprints of] Fifth Rare Earth Research Conference, Aug. 30-Sept. 1, 1965. (In French).

Some rare earths and yttrium were separated by using the fact that their carbonates are relatively insoluble. The relative solubilities of rare earth carbonates and of yttrium carbonate were measured. It was found that $Y_2(CO_3)_3$ is much more soluble than the rare earth carbonates. Therefore, reactions of the type, $Y_2(CO_3)_3 + 2NdCl_3 \rightarrow Nd(CO_3)_3 + 2YCl_3$ gave a considerable increase in the extracted yield.

A small quantity of acid was used to dissolve a portion of the mixture and thus to begin the reaction. (G.O.Y.)

27047 SEPARATION OF RARE EARTH ELEMENTS UNDER SUBCRITICAL CONDITIONS. Mineev, D. A.; Dikov, Yu. P.; Sobolev, B. P.; Borutskaya, V. L. (Inst. of Mineralogy, Geochemistry, and Crystal Chemistry of Rare Earth Elements, Moscow. Moscow Inst. of Crystallography). Geokhimiya, No. 4, 468-70(Apr. 1966). (In Russian).

The assumption that separation of rare earth elements in nature is due primarily to their migration in the form of complexes originated by the acidity changes of postmagnetic mineralizing solutions was experimentally tested. A mixture of La, Ce, and Y, the most widely distributed rare earth elements, and a tenfold excess of NaF were placed in the lower portion of a double crucible within a steel autoclave; the upper portion of the crucible contained oligoclase. The autoclave was filled to about one-third with a 1N solution of HF; the lower half was kept at 550°C, the upper one at 500°C to imitate the naturally prevailing temperature and concentration gradients. After six days of soaking, the system was cooled by quenching. It was found that all of the rare earth oxides in the lower crucible were transformed into fluorides and the albite-type oligoclase in the upper crucible exhibited a 3-mm thick reaction zone containing muscovite and Al + Y fluorides. The method indicated a path for separating ceric-type rare earths from yttrium but not for separating cerium and lanthanum. Thus, the experimental results confirmed the original hypothesis; they may be used to clarify the mechanism of the alkali halide metasomatism of ranitoid minerals. (TTT)

27048 LIQUID-LIQUID EQUILIBRIA. EXTRACTION OF ZIRCONIUM NITRATE BY TRIBUTYL PHOSPHATE. I. EFFECT OF SULFATE IONS ON THE EXTRACTION. Stern, Martine; Chatelet, Marcel (Univ., Paris). J. Chim. Phys., 63: 506-11(Mar. 1966). (In French).

The extraction of zirconium from nitrate solutions into a mixture of White-spirit and tributyl phosphate was studied and the real distribution coefficient was determined. The influence of sulfate ions on the extraction was then investigated, and the composition of a nonextractable complex of zirconium was established. (auth)

27049 SEPARATION OF RARE EARTHS BY LIQUID ION EXCHANGE. IV. RARE EARTH SEPARATION BY PAPER CHROMATOGRAPHY WITH INVERSE PHASES AND COMPLEX ELUTION. Werner, Gerhard (Karl-Marx-Univ., Leipzig). J. Chromatog., 22: 400-6(May 1966). (In German).

Paper impregnated with dinonylnaphthalenesulfonic acid can be used for the chromatographic separation of the rare earths. When using complexing eluents (lactic acid, α-hydroxybutyric acid) the separation factors are determined by the stability of the rare earth complexes. With the exception of the Eu–Gd, Tb–Dy, and Dy–Ho pairs, any 2 to 4 adjacent elements in the series lanthanum, cerium, praseodymium, neodymium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, and ytterbium can be separated on one paper chromatogram. (auth)

27050 EFFECTS OF SEVERAL NEUTRAL DONORS ON THE EXTRACTION OF ^{65}Zn BY DINONYL NAPHTHALENE SULFONIC ACID BY SODIUM DINONYL NAPHTHALENE SULFONATE. Wang, S. M.; Li, N. C. (Duquesne Univ., Pittsburgh). J. Inorg. Nucl. Chem., 28: 1091-1101 (Apr. 1966).

Liquid ion-exchange studies were carried out on the systems ^{65}Zn/HD/S and ^{65}Zn/NaD/S (HD = dinonyl naphthalene sulfonic acid, NaD = sodium dinonyl naphthalene sulfonate and S is a neutral donor: tri-n-octyl phosphine oxide (TOPO), tri-n-butyl phosphate (TBP), or 2-ethyl-n-hexyl alcohol (EHA). Decreased extraction of ^{65}Zn by mixtures of HD and the organo phosphorus esters was observed and ascribed to the formation of the hydrogen-bonded complexes: HD · TOPO and HD · TBP. TOPO formed a stronger complex with HD than did TBP, and exerted a greater depressing effect on the extraction of ^{65}Zn. Enhanced extraction of ^{65}Zn from aqueous 0.25M $NaClO_4$ by mixtures of NaD and TOPO in benzene was found and the overall mechanism may be: $Zn^{2+} + 2/x\ (NaD)_x + n$ TOPO = $ZnD_2 \cdot n$ TOPO + $2Na^+$. When NaD and TOPO are both about 0.001 F, n = 1.65, and x = 8. The average value of the equilibrium constant was found to be 6.1×10^4. Under these conditions, TBP or EHA exerted no effect on the extraction of ^{65}Zn by NaD. (auth)

27051 A COMPARISON OF MONOMERIZED AND DIMERIZED DI(2-ETHYLHEXYL) PHOSPHORIC ACID AS LANTHANIDE EXTRACTANTS: THE SYSTEM $SmCl_3$–HCl–H_2O–1 M D2EHPA. Lenz, T. G.; Smutz, M. (Ames Lab., Ames, Iowa). J. Inorg. Nucl. Chem., 28: 1119-20(Apr. 1966). (IS-1240).

A comparison was made of the monomerized and dimerized forms of di(2-ethylhexyl)phosphoric acid (D2EHPA) as lanthanide extractants at concentrations greater than tracer concentrations in the equilibrium aqueous and organic phases. Equilibrium data for both the monomeric and dimeric extractants are shown. The dimerized D2EHPA appeared to be a more efficient extractant than monomerized D2EHPA under the experimental conditions studied. It is shown that the dimerized D2EHPA extracts ~40 times as much Sm as the monomerized D2EHPA for a given equilibrium aqueous phase. The curves for $LaCl_3$, $NdCl_3$, and $PrCl_3$ were found to be similar to the curve for $SmCl_3$. (F.J.H.)

27052 SEPARATION FACTORS FOR Sm Nd–D2EHPA–H^+–H_2O CHLORIDE AND NITRATE SYSTEMS. Battista, C.; Mize, C.; Smutz, M. (Ames Lab., Ames, Iowa). J. Inorg. Nucl. Chem., 28: 1121-2(Apr. 1966). (IS-1243).

The distribution coefficient for the rare earths between bis(2-ethylhexyl)phosphate and water was investigated for chloride and nitrate systems. The equilibrium concentrations for Sm–Nd chloride mixtures and Sm–Nd nitrate mixtures between bis(2-ethylhexyl)phosphate and water are shown. The separation factors, distribution coefficients, and material balances deviated between the duplicate determinations by less than ±2%. The results showed that the separation factor for Sm with respect to Nd was higher for chloride systems than for nitrate systems at all concentrations studied. It was also observed that the separation factor for the chloride and nitrate systems were depressed by the addition of acid. (F.J.H.)

27053 SEPARATION OF RUTHENIUM BY THE SELECTIVE DISTILLATION METHOD. Fujinaga, Taitiro; Koyama, Mutsuo; Kanchiku, Yoshihiko (Kyoto Univ.). Nippon Kagaku Zasshi, 87: 369-71(Apr. 1966). (In Japanese).

A distillation method was proposed for the separation of Ru from Tc and Re. Because of the high volatility of RuO_4, Ru oxidized to the highest valence is distilled from either acidic or basic solutions. The selective distillation of carrier-free Ru with H_2O_2 oxidation in the sulfuric acid solution and with Br_2 oxidation in the alkaline solution was investigated. The distillation with H_2O_2 oxidation gave a good yield and separation of Ru from Tc was found to be possible. A portion of Tc was, however, oxidized to volatile Tc_2O_7 with the procedure and the separation was not very satisfactory. The quantitative isolation of Ru was possible, however, by distilling RuO_4 from alkaline solutions containing Br_2 in which Tc and Re are nonvolatile presumably as anions such as TcO_4^- and ReO_4^-. (auth)

27054 THE RADIOCHEMICAL SEPARATION OF SOME METAL SALTS BY EXTRACTION CHROMATOGRAPHY ON POWDERED POLYTETRAFLUOROETHYLENE IN THE SYSTEM TRI-n-OCTYLPHOSPHINE OXIDE-MINERAL ACIDS. Stronski, Ignacy (Inst. of Nuclear Physics, Krakow); Bittner, Maria; Kruk, Janina. Nukleonika, 11: 47-55(1966).

The conditions for separation of salts of Ni(II), Cu(II), Zn(II), Sr(II), Y(III), Cd(II), Tb(III), Pb(II), Bi(III), Th(IV), and U(VI) on a small chromatographic column of polytetrafluoroethylene (teflon) supporting tri-n-octylphosphine oxide (TOPO) were investigated, using the radiotracer method. The separation of the mixtures Ni–Cu, Cu–Zn, Sr–Y, Pb–Bi, Th–U and Cd–Tb–U, and the preparation of carrier-free radioisotopes of ^{90}Y and ^{206}Bi are described. (auth)

27055 THE RADIOCHEMICAL SEPARATION OF SOME METAL IONS BY EXTRACTION CHROMATOGRAPHY ON POWDERED POLYTETRAFLUOROETHYLENE IN THE SYSTEM TRI-n-OCTYLAMINE-ELECTROLYTE. Mikulski, Jan (Inst. of Nuclear Physics, Krakow). Nukleonika, 11: 57-9(1966).

Tb(III), Hf(IV), Cd(II), Zn(II) were separated from U(VI), Am(III) from Pu(VI), Te(IV) from Sb(V), and Ni(II) from Co(II) and Cu(II) in the system tri-n-octylamine–HCl on teflon. Data are presented in graphs. (M.C.G.)

27056 RAPID RADIOCHEMICAL SEPARATIONS. II. SEPARATION OF EUROPIUM FROM OTHER LANTHANIDES. Malan, H. P.; Muenzel, H. (Nuclear Research Centre, Karlsruhe, Ger.). Radiochim. Acta, 5: 20-3(Mar. 1966).

The rapid chemical separation of europium from neighboring lanthanides was investigated. Details are given of a procedure by means of which europium was separated in about 50% yield from irradiated samarium targets within one minute. The separation factor with respect to samarium was about 10^3, and with respect to other lanthanides, one to several orders of magnitude greater. (auth)

27057 RAPID RADIOCHEMICAL SEPARATION BY ADSORPTION. Rai, R. S.; Nethaway, D. R.; Wahl, A. C. (Washington Univ., St. Louis). Radiochim. Acta, 5: 30-4 (Mar. 1966).

Conditions are described under which rapid and essentially quantitative adsorption occurs from aqueous solutions for $^{140}Ba^{2+}$ on $BaSO_4$(s), $^{90}Sr^{2+}$ or $^{85}Sr^{2+}$ on $SrCO_3$(s), and $^{113}Sn^{4+}$ on SnS_2(s) or SnS(s). The presence of U^{6+} in solution does not interfere with the adsorption. These processes, which may involve isotopic exchange, offer convenient and rapid methods for the separation of Cs^+ from Ba^{2+} at low concentration, Rb^+ from Sr^{2+} at low concentration, and In^{3+} from Sn^{4+} at low concentration, and thus the processes are applicable to the separation of short-lived fission products from their immediate descendants. (auth)

27058 INVESTIGATION OF THE EXTRACTION OF U(IV) AND U(VI) FROM HYDROCHLORIC ACID SOLUTIONS BY MEANS OF TRI-N-BUTYLPHOSPHATE. Vdovenko, V. M.; Lipovskii, A. A.; Nikitina, S. A.; Yakovleva, N. E. Radiokhimiya, 7: 509-16(1965). (In Russian).

Uranium was extracted from the aqueous phase by forming complex compounds, which accumulated in the organic phase. The optical method (percent transmission of 400 to 700 mμ) was applied to measurement of the concentration of uranium–tri–n–butyl phosphate complexes in the organic phase. In the extraction experiments 0.5 to 12.8 molar HCl solutions and 5 to 10.9 molar LiCl solutions were used. It was found that the composition of the complexes formed is a function of both the HCl concentration in the aqueous phase and the TBP concentration in the inert solvent. In the case of U^{6+}, the following complexes were found in the extracts: $UO_2Cl_2(TBP)_2$, $UO_2Cl_2(TBP)_3$, and a complex anion $[UO_2Cl_3(TBP)_2]^-$. In the case of U^{4+}, the organic phase contained $UCl_4(TBP)_2$, $UCl_4(TBP)_3$, and a complex anion UCl_6^{2-}. Under the conditions near saturation equilibrium, both U^{4+} and U^{6+} are combined with two molecules of TBP. In the case of an excess of TBP, the complex involves three molecules of TBP. In the case of higher HCl concentration in the starting aqueous solution, accompanied by an excess of TBP, the extract contains anionic complexes of U^{4+} and U^{6+}. (ATD)

27059 INVESTIGATION OF UCl_4 SOLVATION BY MOLECULES OF NEUTRAL ORGANOPHOSPHATE COMPOUNDS BY SPECTROSCOPIC METHODS. Lipovskii, A. A.; Nikitina, S. A.; Yakovleva, N. E. Radiokhimiya, 7: 563-72(1965). (In Russian).

Solvation of UCl_4 by tri-n-butyl phosphate (TBP), diisoamine ester of methylphosphonic acid (DAMPA), and tributylphosphine oxide (TBPO) was investigated using optical methods. Saturated solutions of anhydrous UCl_4 in solvents containing TBP, DAMPA, and TBPO in CCl_4 and benzene were used. It was found that in the case of an excess of phosphoorganic ligands in inert solvents, complexes of the general formula UCl_4S_3 are formed (where S is TBP, DAMPA, or TBPO). The equilibrium contents of the reaction $UCl_4S_2 + S \rightleftharpoons UCl_4S_3$ are 55 ± 3, 117 ± 12, and 86 ± 4 for TBP, DAMPA, and TBPO, respectively. Changes in the absorption spectra of U^{4+}, which occur at high DAMPA and TBPO concentrations are attributed to coordinatively saturated compounds of the UCl_4S_4 type. The increase in ligand concentration was found to be reflected in weaker bonds between U^{6+} or U^{4+} and phosphoorganic ligands in UCl_4S_3 type complexes. It was found that the electron affinity of heavy metal salts can be measured in terms of displacement in the infrared absorption spectra of the P = 0 group of the coordination compounds containing equal numbers of neutral ligands. The similarity of the absorption spectra of UCl_6^{2+} and UCl_4S_2 indicated that the ligands are arranged octahedrally around the U^{4+} ion in the UCl_4S_2 complex. A low symmetry was assigned to the UCl_4S_3 compound. (ATD)

27060 HYDROMETALLURGY PERMITS THE TREATMENT OF LOW-GRADE ORES. THE EXAMPLE OF COPPER AND URANIUM. Villard, Raoul. Sci. Progr.-Nature, No. 3372, 138-44(Apr. 1966). (In French).

The hydrometallurgical techniques used to extract copper and uranium from very-low-grade ores are reviewed. Examples are given of the practical utilization of these techniques. (J.S.R.)

27061 RADIOCHEMICAL SEPARATION OF ANTIMONY BY ISOTOPIC EXCHANGE. Qureshi, Iqbal H.; Shabbir, Muhammad (Atomic Energy Center, Lahore). Talanta, 13: 847-52(June 1966).

Isotopic exchange was used to develop a simple and rapid procedure for radiochemical separation of antimony. A number of variables that affect the yield were studied and optimized, and antimony yields of 96% were obtained at 30°C. Acids and alkalies decreased the yield. The mode of preparation of the antimony oxide precipitate and the temperature also affected the isotopic exchange. Studies made with radioactive tracers of 14 different elements showed contamination of <1% for most elements. The high contamination with $^{96}Zr-^{95}Nb$ could be reduced considerably by adding carrier. The procedure can be carried out in about 13 min and does not require any special equipment. (auth)

27062 CONCENTRATION AND PURIFICATION OF ^{231}Pa AND ^{233}Pa. Davydov, A. V.; Myasoedov, B. F.; Novikov, Yu. P.; Palei, P. N.; Pal'shin, E. S. Tr. Kom. Anal. Khim., Akad. Nauk SSSR, Inst. Geokhim. Anal. Khim., 15: 64-79(1965). (In Russian).

Treatment of fertile materials containing Th of breeder reactors and separation of ^{231}Pa from neutron-irradiated ^{230}Th involves the removal of protactinium from thorium and the fission product elements. A method was developed and the conditions of extraction, sorption, and coprecipitation steps for concentrating, separating, and purifying Pa were examined. Internal complexes of Pa with 1,8 dioxy naphthalene-3,6-disulfonic acid, 2,7-bis (azo-2) phenylarsonic acid (arsenazo III), thenoyl trifluoro acetone (TTA), and N-benzoyl phenyl hydroxylamine (BPHA) were used for the extraction step. BPHA was found useful for separating Pa from Nb, U, Fe(III), Th and La, but Zr, Bi, and Po were not completely separated. Arsenazo III and TTA were used for separating and purifying Pa in U ores and concentrates. Color reactions allowed photometric measurements to be made. The radiation-resistant silica gel was found useful for the sorption of Pa from highly irradiated mixtures; Th, U(VI), Po, Ru, and Ce are removed from the gel with 6M HNO_3. The Pa was desorbed by organic and inorganic complexing agents, such as oxalic acid. Activated carbon saturated with various reagents was also a potentially good separating agent. For concentrating Pa, coprecipitation with Zr phosphate and MnO_2 were used. The analytical conditions are described in detail. (TTT)

27063 EXTRACTION OF RARE EARTHS BY LONG-CHAINED TERTIARY AMINES. Wolf, L.; Matzel, W.; Schreiber, H. M. Wiss. Z. Karl-Marx-Univ. Leipzig, Math. Naturw. Reihe, 14: 551-3(1965). (In German).

Rare earths can be extracted by long-chain tertiary amines from strong nitrate-containing solutions with low concentrations of free nitric acid. Lithium nitrate and calcium nitrate are very suitable as desalting agents. In the organic phase the rare earths are present as $(AH)_3(RE(NO_3)_6)$ with A = tertiary amine. The variation in the extractability of the individual rare earths can be used for their separation with utilization of sufficiently powerful multistage apparatus. (tr-auth)

27064 ON THE PARTIAL SEPARATION OF GAS AND ISOTOPE MIXTURES BY COMPRESSION SHOCKS. Bier, K.; Zeller, R. (Kernforschungszentrum, Karlsruhe, Ger.). Z. Naturforsch., 20a: 1519-29(Nov. 1965). (In German).

In the free expansion of gas mixtures a partial separation of various heavy components occurs that is greatest in the transition region between gas dynamic and molecular flow behavior and which is explained essentially by the pressure diffusion in the pressure drop of the free expanding gas current arising perpendicular to the flow direction. Previous studies on the reversal of the separation direction in super-expanding gas beams showed quantitatively that a corresponding separation effect can also be observed in the irregular reversal of a supersonic flow in an oblique compression shock. The separation and oblique compression shock, produced in the internal zone of a free expanding gas by a needle-shaped obstacle, was investigated quantitatively as a function of the gas density and the gas kinetic properties of the mixture components. It is shown that the separation current at the collision front under gas dynamic flow conditions for a binary mixture is proportional, within the limits of error, to the relative pressure gradient, the relative mass difference, and the product of particle density and diffusion constant (that is, independent of the gas density) as is true for normal pressure diffusion. Since under the research conditions used a pressure increase of a factor of 1.5 to 1.6 per mean free wavelength is present in the shock front, the results indicate that the validity range for the general diffusion law in the first approximation of gas kinetics is apparently larger than was expected from the derivation which assumes small relative state changes of the free wavelengths. (tr-auth)

27065 EXTRACTION OF RARE EARTH ELEMENTS OF THE CERIUM SUBGROUP WITH THE DIISOAMYL ESTER OF METHYLPHOSPHONIC ACID. Mikhlin, E. B.; Korpusov, G. V. Zh. Neorg. Khim., 10: 2787-95(Dec. 1965). (In Russian).

A systematic investigation was made of the extractive properties of the diisoamyl ester of methylphosphonic acid with respect to individual rare earth elements and of the possibility of its use for their separation. To avoid hydrolysis, extractions were made from weak nitrate solutions in which the content of free nitric acid did not exceed 0.2–0.25 N. The oxides of the rare earth elements (lanthanum, cerium, praseodymium, neodymium, samarium) contained more than 99.9% of the basic element. Also tested were binary mixtures and different concentrates. The acidity of the diisoamyl ester of phosphonic acid did not exceed 0.0005 N. Distribution coefficients for the extractions were determined. At an acidity of the aqueous phase of 0.1–0.2 N in HNO_3, the extractive capacity of the diisoamyl ester of methylphosphonic acid attained 200–205 gram/liter of total rare earth oxides. Saturation of the organic phase for the diisoamyl ester of methylphosphonic acid was reached at lower equilibrium concentrations of rare earth elements in the aqueous phase than for tributyl phosphate. This made it possible to use a lower concentration of the salting out agent—$Al(NO_3)_3$—of the order of 2 or 3 N. Using 5 N $Al(NO_3)^3$ as a salting out agent, high values of the order of 2.5–3 were obtained for the separation coefficients for the vapors of lanthanum, cerium, neodymium, and samarium, which made possible the use of the diisoamyl ester of methylphosphonic acid for the separation of rare earth elements of the cerium subgroup. (ATD)

27066 SEPARATION OF RARE EARTH ELEMENTS BY FRACTIONAL PRECIPITATION WITH ANION EXCHANGERS. Ryabinin, A. I.; Sorokina, A. A. (Inst. of Inorganic Chemistry, SiberianSSR). Zh. Prikl. Khim., 38: 2410-14(Nov. 1965). (In Russian).

Data on the fractionation of lanthanum with an EDE-10 anion exchanger in the hydroxyl form are presented. The possibilities of efficient concentration of samarium with anion exchangers in the hydroxyl form and the separation of lanthanum from didymium with anion exchangers in the carbonate form are demonstrated. The experimental data are presented in tabular form and show the effect of the amount of the EDE-10 anion exchanger and the duration of the precipitation on the purity of the lanthanum oxide, its degree of extraction, and the amount of precipitated rare earth element. Experiments were carried out with a total rare earth concentration containing 20.7% didymium at room temperature. Data on the separation of lanthanum oxide, approximately 98.5% pure, from mixtures of rare earth elements of various compositions are presented. It was concluded that double fractionation with the EDE-10 anion exchanger in the hydroxyl form makes it possible to obtain lanthanum oxide 99.5 to 99.7% pure. The experiments demonstrated the possibility of the efficient separation of other rare earth elements (for example, samarium) in the hydroxyl form by the use of anion exchangers. Using the example of the EDE-10 anion exchanger in the carbonate and oxalate forms, the possibility of the fractional separation of rare earth elements in the form of salts is shown. (ATD)

27067 EXTRACTION OF THORIUM FROM DILUTE SOLUTIONS BY MEANS OF TANNATE OF GELATIN. Keshishyan, G. O.; Andreev, P. F.; Danilov, L. T. Zh. Prikl. Khim., 38: 2842-4(Dec. 1965). (In Russian).

A method is presented for extraction of thorium from highly diluted aqueous solutions containing $CaCl_2$, Na_2SO_4, and NaCl. The object of the work was to examine the feasibility of extracting thorium from sea water. Edible gelatin and imported DAB-6 tannin were used as extraction agents. Thorium was precipitated from solutions containing 100 to 200 micrograms of ^{232}Th and some radioactive ^{234}Th per 500 ml of starting solution, using 5 ml of 1% solution of DAB-6 tannin and gelatin. Thorium removal from a solution containing various natural salts and from simulated sea water is shown. It was found that tannate of gelatin effectively extracts thorium from diluted solutions in a wide range of pH and concentration. Thorium extraction is facilitated by the presence of neutral salts, in particular $CaCl_2$. In the case of a solution containing $CaCl_2$ complete extraction of thorium is achieved for pH ranging from 3 to 9. (ATD)

27068 THE ^{99m}Tc GENERATOR. Richards, P. (Brookhaven National Lab., Upton, N. Y.). pp 323-34 of CONF-651111.

A combination of useful nuclear properties of 6-hr ^{99m}Tc of interest in nuclear medicine led to the development of a simple, rugged, and compact generator that makes the short-lived isotope available for use at locations far removed from sources of production. Parent ^{99}Mo is produced as a separated carrier-free fission product or by neutron bombardment of molybdenum. Each method has advantages and disadvantages. The separated fission product, because it yields higher product concentrations, is the most widely used material in the nuclide generator. The daughter ^{99m}Tc is eluted with physiological saline solution. The process separates ^{99m}Tc from the parent ^{99}Mo in a form requiring little further processing for clinical use. The ^{99}Mo remaining in the generator continues to decay and forms fresh ^{99m}Tc of which the activity reaches a maximum every 23 hr, permitting several elutions per day. (auth)

27069 METHOD FOR EXTRACTING LANTHANIDES AND ACTINIDES. Siddall III, T. H. (to U. S. Atomic Energy Commission). U. S. Patent 3,243,254. Mar. 29, 1966.

A method is described for the recovery of trivalent lanthanide and actinide values from acidic aqueous solu-

tions by contacting these solutions with certain bidentate organophosphorus extractants, such as dihexyl-N,N-diethylcarbamylphosphonate or dihexyl-N,N-diethylcarbamylmethylenephosphonate. These extractants either alone or dissolved in an inert organic diluent are particularly suitable for recovery of trivalent cerium, promethium, and americium values from concentrated aqueous waste solutions. (AEC)

ENGINEERING

General

27070 (TID–4100(Suppl.33)) SUPPLEMENTAL INSERT SHEETS FOR ENGINEERING MATERIALS LIST. Sachs, Francis L. (ed.) (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). May 1966. 58p. Dep. DTI Extension Free.

Announcement is made of the public availability of engineering drawings, specifications, parts lists, and related materials of instruments, reactors, devices, etc., which are developed under research and development programs of the USAEC. 24 CAPE packages are described. (P.C.H.)

27071 ATOM I ORUZHIE. NAUCHNO-TEKHNICHESKII PROGRESS I VOENNOE DELO. SBORNIK STATEI. (Atom and Weapons. Scientific-Technological Progress and Military Affairs. Collection of Articles). Krasil'nikov, S. N. (ed.). Moscow, Publishing House of the USSR Ministry of Defence, 1964. 343p.

Data are cited to illustrate how the conduct of war has changed under the impact of scientific discoveries. It is pointed out how advances in strength of materials, nuclear science and rocketry can be used in the armed forces. The scientific principles involved in a thermonuclear electric generator, an atomic electric generator, ion and plasma rockets, lasers, servomechanisms, remote-controlled manipulators and cybernetics are discussed in an elementary fashion. The capabilities of various rockets equipped with thermonuclear weapons are given. The range, speed, and payload of the rockets are presented. The methods of rocket detection, the use of computers and radar nets in meeting the threat of atomic and thermonuclear rockets, and the various types of missiles (air to ground, ground to air, etc) are discussed. Separate abstracts are prepared for 3 of the 8 sections. (TTT)

For abstracts of individual sections see: 27072, 27073, and 28824.

27072 SCIENCE AND ROCKET-NUCLEAR WEAPONS. Anureev, I. I. pp 61-110 of Atom i Oruzhie. Moscow, Publishing House of the USSR Ministry of Defence, 1964. (In Russian).

After reviewing the classical physical theory and the great change in concepts caused by Einstein's theory of relativity, the most important milestones of modern physics are recalled briefly. In the discussion of the importance of the discovery of nuclear fission, the tremendous amount of energy that became available through the fission and fusion of nuclei is emphasized. Use of these energy sources for military purposes is reviewed, mentioning that future applications will hopefully provide the means to carry out interplanetary and interstellar space flights. In reviewing the development of aerodynamics and rocket dynamics, the contributions of Tsiolkovskii and Meshcherskii to the technology of modern rocketry are underlined. This science depends to a great extent on further development of the materials science, propellant chemistry and refractories. Mathematics played the same role for rocket technology as earlier for artillery. The military problems involved in the use of atomic and thermonuclear weapons are examined, mentioning the fallout problem, and the friction-induced heat during the flight of rockets. Ballistic and other types of missiles are considered from the operational viewpoint. The Soviet and US satellite programs are compared. (TTT)

27073 RADIOELECTRONICS FOR MILITARY PURPOSES. Tikhonov, I. I. pp 152-99 of Atom i Oruzhie. Moscow, Publishing House of the USSR Ministry of Defence, 1964. (In Russian).

Radio-electronics exerted a strong influence on the development of military techniques. At present it is used for controlling an army in the field, for aerial and marine navigation, for the guidance of rockets and missiles, and for reconnaissance activities against the enemy. Radio-electronic techniques are often used for direct interference with the enemy's activities, creating unfavorable conditions for the deployment of his forces. The military preparedness of a country may be judged from the level of sophistication of its military radioelectronic system. This technique is of special importance for controlling and guiding intercontinental ballistic missiles carrying nuclear warheads, as it is suitable for solving problems involving great distances and requiring immediate reaction. The extreme accuracy needed for guidance and satellite control could not be achieved conveniently by other means. Its importance is shown by the fact that in the USA the electronics industry ranges in the third place, immediately after the automobile and steel industries. Reconnaissance operations are carried out by intercepting the opponent's messages and other signals and locating the transmitters, using u-h-f radiowaves for determining the angular coordinates. Radar systems are able to detect bombers flying at altitudes exceeding 10,000 m. Warning systems have been established in the USA and Canada but they are primarily effective against manned planes and winged rockets; intercontinental ballistic missiles may arrive from unexpected directions. For naval operations, hydroacoustic detection means are used. Military television is another valuable tool, allowing the field commander to keep in touch with the situation. Individual systems are outlined. (TTT)

27074 MAGNETOHYDRODYNAMIC COUPLING OF MOMENTUM EMPLOYING A LIQUID-METAL FLYWHEEL. Martinson, L. K. Magnit. Gidrodin., No. 4, 85-90(1965). (In Russian).

A scheme for using liquid metal flywheels in place of solid ball bearing flywheels is studied with respect to improved performance and reliability. A schematic of the liquid metal flywheel is presented, and its properties are computed. Starting with a conservation of momentum for the entire system and considering the operation to be time-independent, magnetohydrodynamic equations for fluid velocity, and azimuthal magnetic field are derived. Density, viscosity, and electric conductivity are taken to be constant. Based on the appropriate Maxwell equation, solutions are obtained for a set of boundary conditions specifying laminar flow. The solution requires, further, the assumption that the axial current is negligible in comparison to the radial current. These assumptions are well suited to the device under consideration. The final form of the solution is the expression for the relative angular velocity of the electrodes and is given as a function of the electrical and physical parameters of the device. In addition, velocity relaxation time is discussed for the case of the step-function form of the control voltage. A numerical example is also considered. (ATD)

27075 ELECTROMAGNETIC FORCE IN AN INFINITELY WIDE CONDUCTING LAYER PLACED IN A TRAVELING MAGNETIC FIELD OF PLANE INDUCTORS. Veze, A. K.; Krumin, Yu. K. Magnit. Gidrodin., No. 4, 99-107 (1965). (In Russian).

The electromagnetic forces in an infinite conducting sheet placed in a traveling field produced by an induction coil on one or both sides of the sheet are considered. The purpose of the study is to clarify certain unsolved problems in the theory of plane linear induction pumps. Both tangential and normal components of the force are computed, assuming that the tangential component of magnetic field at the surface of the sheet is given. The forces arising when there is an arbitrary phase relationship between two induction coil currents are written in terms of forces for 0 and 180° phase relationship. Forces for these two special cases are plotted as functions of the frequency of the inductor current and normalized sheet thickness. In the general case, the frequency dependence of forces has a maximum. It is further shown that the normal components of the force vanishes as the inductors are placed symmetrically, relative to the sheet. The amplitude of the magnetic field is also computed as a function of inductor coil current and frequency.

It is concluded that the data can be used in the design of electromagnetic devices employing pondermotive forces in a traveling electromagnetic field. (ATD)

27076 DESIGN AND APPLICATION OF INDUCTORS WITH PERMANENT MAGNETS. Goltseva, S. A.; Zvenigorodskii, E. G.; Niktin, B. I. Magnit. Gidrodin., No. 4, 141-7(1965). (In Russian).

The results of an experimental investigation of the relationship between the size of a uniform field region and the dimensions of magnets in inductors with permanent and rotating magnets are reported. The data are presented in dimensional form so that the results can be generalized for the eighty systems investigated. Both rotary and nonrotary inductors were studied. Departures of the magnetic field from uniformity of 1, 3, and 5% were used as test criteria and the optimum relationship between the various dimensions was established. Approximate analytic expressions were determined empirically for optimum dimensions of magnets for rotating inductors which move through periodic fields of circumferentially located magnets. (ATD)

Applications of Nuclear Explosions

27077 (LA-DC-7272) SCIENTIFIC APPLICATIONS OF NUCLEAR EXPLOSIONS. Diven, B. C. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [1965]. Contract W-7405-eng-36. 28p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

Laboratory neutron sources are compared with explosion sources. The advantages of explosion sources are pointed out. A few experiments that were performed using explosion neutrons are discussed. (M.O.W.)

Facilities and Equipment

27078 (SLAC-56) A COMPUTER CODE FOR VARIABLE PERMEABILITY MAGNETOSTATIC FIELD PROBLEMS. Burfine, E. A.; Anderson, L. R.; Brechna, H. (Stanford Linear Accelerator Center, Stanford Univ., Calif.). Apr. 1966. Contract AT(04-3)-515. 54p. Dep. mn. CFSTI $3.00 cy, $0.50 mn.

A method for solving variable permeability two-dimensional and axially symmetric magnetostatic problems is discussed and the implementation of this method in the computer code NUTCRACKER is explained. (auth)

27079 CAPSULE FOR GAMMA IRRADIATION OF SOLID-LIQUID SYSTEMS. Melkonian, G. A.; vom Baur, E. (Institut fuer Reaktorphysik der Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Geesthacht, Ger.). Kerntechnik, 8: 171-2(Apr. 1966). (In German).

A sketch is given of the capsule design and of γ irradiation of solid-liquid systems and it is described. (J.S.R.)

27080 EQUIPMENT FOR WORKING WITH GAMMA-ACTIVE NUCLIDES. Schlums, K.-D. (Technische Hochschule, Brunswick). Kerntechnik, 8: 180-2(Apr. 1966). (In German).

A simple device for working with γ-active nuclides with medium activities is described. The remote handling tongs and stretching devices are used in the installation are illustrated in some detail. (J.S.R.)

27081 THE NRL HIGH LEVEL RADIATION LABORATORY. PART I. STRUCTURAL DESIGN AND CONSTRUCTION FEATURES. Watson, H. E.; Steele, L. E. (Naval Research Lab., Washington, D. C.). Nucl. Eng. Design, 3: 299-307(1966).

The High Level Radiation Laboratory of the U. S. Naval Research Laboratory, which was designed as a general purpose radiation facility, has undergone the usual startup procedures and it is now possible to describe this laboratory from the perspective of more than a year of operation. A description of the main structural design and construction features of the NRL High Level Radiation Laboratory is given, such as: design criteria, hot cell shielding, radiation shielding viewing windows, hot cell access and intercell transfer facilities, cell electric services and in-cell lighting, ventilation system, liquid radioactive waste disposal system, safeguards system. (auth)

27082 DESIGN OF A MOBILE IRRADIATOR. Morton, Maxwell R.; Klaassen, Willem J. (Vitro Engineering Co., New York). Nucl. Eng. Design, 3: 353-62(1966).

A description of the design of a mobile gamma irradiation unit capable of processing 1000 lb/hr of field products at radio-pasteurization doses up to 225,000 rads is given. The mobile irradiator uses a 128,000 C cobalt-60 source. It consists of a quadrant irradiator system, a lead shielding cask, hydraulic system, refrigeration and ventilating system, instrumentation, conveying system, etc., mounted on a trailer bed which can be moved using a standard trailer tractor. (auth)

27083 DESIGN AND EQUIPMENT OF THE JAERI POST IRRADIATION EXAMINATION FACILITY. Iso, Yasuhiko; Sakakura, Atsushi (Japan Atomic Energy Research Inst., Tokyo). Nucl. Eng. Design, 3: 105-16(Jan. 1966).

Some details of design and construction of mechanical devices for the post irradiation examination facility in JAERI (Japan Atomic Energy Research Institute) are given. Shielding-door drive mechanism, cell-conveyor system, sample-transfer ports were devised with respect to complete remote control. Also are presented general descriptions of layout, cell compositions and other mechanical equipment. (auth)

27084 THE NRL HIGH LEVEL RADIATION LABORATORY. PART II. LABORATORY FUNCTIONS AND EQUIPMENT. Watson, Henry E. (Naval Research Lab., Washington, D. C.). Nucl. Eng. Design, 3: 439-40 (Apr. 1966).

As a continuation of a detailed description of the U. S. Naval Research Laboratory High Level Radiation Laboratory (HLRL), this report describes the function of each area of the laboratory and the equipment employed for the safe and efficient execution of the programs associated with radiation effects research. (auth)

27085 MACHINE FOR REMOVING THE CARTRIDGES OF NUCLEAR REACTOR FUEL ELEMENTS. Alles, Maurice; Aymard, Jose; Marin, Denis; Pellerin, Achille (to Commissariat a l'Energie Atomique). German Patent 1,210,494. Feb. 10, 1966. Priority date May 3, 1960, France.

The machine consists of a supporting structure provided with a jack and with cutting wheels arranged to cut the cartridge when the fuel element is displaced by the movable portion of the jack. An assembly of fingers is arranged symmetrically around the longitudinal axis of the fuel element, each of which is articulated to supports fixed to the supporting structure. The axes of articulation of these links form a parallelogram, which is deformable when the fingers are engaged within the cartridge. The fuel element is displaced by the movable portion of the jack to separate the fingers and thereby to cut portions of the cartridge. (Gmelin Inst.)

Heat Transfer and Fluid Flow

See also PHYSICS — Fluid Physics and Thermodynamics

Refer also to abstract 28696.

27086 (AERE-R-5128) AN OUTLINE OF THE CHARACTERISTICS AND CONSTRUCTION OF THE DATA ACQUISITION SYSTEM USED ON THE HARWELL HIGH-PRESSURE STEAM/WATER LOOP. Benn, D. (Atomic Energy Research Establishment, Harwell (England)). Feb. 1966. 18p. Dep. BIS $0.60. HMSO 3s.

The system described is intended to record millivolt signals from thermocouples and pressure transducers in either digital or analog form with minimal interference from spurious signals and with high accuracy. The digital

system is capable of recording with a sensitivity of 10 micro-volts, sampling the 50 possible inputs at one per second giving a typewritten output. The performance is somewhat better than could be expected from the maker's specifications and is subject to use in a unipolar mode. In analog form, the inputs can be recorded on a high sensitivity, low noise, six channel pen recorder. (auth)

27087 (ANL–7056) AN INVESTIGATION OF LIQUID-METAL HEAT TRANSFER IN A COCURRENT-FLOW, DOUBLE-PIPE, HEAT EXCHANGER. Merriam, Richard L. (Argonne National Lab., Ill.). June 1965. Contract W-31-109-eng-38. 120p. Dep. mn. CFSTI $4.00 cy, $0.75 mn.

An analytical and experimental investigation of liquid-metal heat transfer in cocurrent-flow, double-pipe, heat exchangers is presented. The analysis predicts local and fully-developed heat-transfer coefficients, as well as overall rates of heat transfer. It is shown that: heat-transfer coefficients depend upon the operating conditions of the heat exchanger, and their values can be significantly lower than those corresponding to a uniform-surface-temperature boundary condition; and use of the customary design equation to predict heat-exchanger performance can lead to significant errors. The construction of a mercury heat-transfer loop and experiments with cocurrent-flow, double-pipe, heat-exchanger, test sections is described, including application of a new experimental technique to obtain values of fully-developed heat-transfer coefficients. The experimental results showed agreement with the analysis. (69 references.) (auth)

27088 (ANL–7100, pp 9-22) HEATING TECHNIQUES FOR LIQUID METAL LOOPS. Holtz, Robert E. (Argonne National Lab., Ill.).

The capabilities of thermal radiation heating and electron-bombardment heating for providing high, relatively uniform heat fluxes to flowing liquid metals in heat transfer loops are examined. (W.L.G.)

27089 (ANL–7100, pp 23-44) ELECTRICAL HEATER FOR LIQUID METALS AT ELEVATED TEMPERATURES. Hays, Lance G. (Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena).

The analysis and preliminary design of a five Mw conduction heater for Cs–Li liquid metals based on existing high temperature electrical breakdown data for fired ceramics are described. A 100 kw heater was fabricated to test geometrically similar heater elements in Li at high temperatures to determine the breakdown strength and insulator leakage currents for swaged ceramics, and to verify design and fabrication methods. (W.L.G.)

27090 (ANL–7100, pp 45-52) FLOW INSTRUMENTATION AND OPERATING EXPERIENCE IN A CONDENSING ALKALI METALS TEST LOOP. Fisher, C. R.; Moskowitz, J. H. Jr. (Aerojet-General Nucleonics, San Ramon, Calif.).

A diagram of the loop in which the condensing heat transfer properties of Cs and Rb were investigated for both horizontal and vertical flow in a straight, round duct is given. The difficulties encountered during the loop operation and calibration of a magnetic flowmeter, due mainly to surface effects, are described. Results of preliminary measurements on condensing Cs and Rb are given. (W.L.G.)

27091 (ANL–7100, pp 53-96) HEAT TRANSFER AND PRESSURE DROP MEASUREMENTS FOR HIGH-TEMPERATURE BOILING POTASSIUM IN FORCED CONVECTION. Bond, J. A.; Peterson, J. R.; Tippets, F. E. (General Electric Co., Cincinnati, Ohio. Space Power and Propulsion Section).

Instrumentation and measurement techniques used for experiments with forced convection boiling potassium in a sodium-heated Haynes-25 alloy test facility at potassium temperatures to 1750°F and in a radiant-heated Nb–1Zr facility at temperatures to 2100°F are described. Some of the heat transfer and pressure drop results obtained are presented. The heat transfer data presented include measurements of heat transfer coefficients in the nucleate boiling and transition boiling regimes and measurements of onset of critical heat flux conditions. (auth)

27092 (ANL–7100, pp 97-126) MEASUREMENTS OF FORCED-CONVECTION CONDENSING POTASSIUM HEAT TRANSFER. Sawochka, S. G. (General Electric Co., Cincinnati, Ohio. Space Power and Propulsion Section).

A discussion of temperature and flow rate measuring techniques, which have allowed the determination of heat transfer and pressure change data for the forced convection condensation of potassium, is presented. Intercalibration of the condensing test section thermocouples is discussed, and representative tube wall radial temperature profiles and potassium axial temperature profiles are presented. (auth)

27093 (ANL–7100, pp 165-86) PRESSURE TRANSDUCER FOR LIQUID METAL APPLICATIONS. Cassano, Anthony J.; Engdahl, Richard E. (Consolidated Controls Corp., Bethel, Conn.).

Development of a pressure transducer for use in liquid metal flow loops poses many design problems demanding the best from available materials. The development of a pressure transducer providing accurate measurements in the liquid, vapor, and two-phase streams of a potassium loop operating at temperatures up to 1800°F is discussed. In addition to potassium, the transducer may also find use in loops containing sodium, lithium, cesium, or rubidium. The transducer employs a thermionic diode sensor to convert the motion of a pressure-actuated refractory alloy capsule into a suitable electrical output. (auth)

27094 (ANL–7100, pp 189-94) FORCED CONVECTION BOILING SODIUM STUDIES AT LOW PRESSURE. Heineman, J. B. (Argonne National Lab., Ill.).

The design and operation of apparatus and instrumentation, designed to obtain information concerning the vapor volume fraction, two-phase frictional losses, and boiling stability of flowing sodium at low pressure, are described. (W.L.G.)

27095 (ANL–7100, pp 195-215) X-RAY MEASUREMENT OF VOID DYNAMICS IN BOILING LIQUID METALS. Wentz, L. B.; Neal, L. G.; Wright, R. W. (TRW Systems, Redondo Beach, Calif.).

X-ray void fraction measurement techniques similar to those used in water are useful for void fraction measurements in liquid metal systems. Such measurements can be used to follow the rapid changes of void fraction that occur with boiling in liquid metals. Experimental results show that these changes occur in milliseconds. Sodium and potassium have about the same x-ray attenuation coefficients as water over a wide range of energies, so the differences between them are mainly in boiling behavior. Potassium is somewhat more opaque to x-rays in the photoelectric region than water and sodium, but it becomes very similar to them above 100 kev. In liquid metals with high atomic number, such as mercury and cesium, prohibitively high energies may be required to stay within the linearity bounds stated above for measuring more than just small fluctuations about a reference void fraction. Electronic system drifts must be considered in any given experimental situation when linearity and quantum noise limitations are low enough to permit high accuracy. With good equipment and frequent calibration, measurements in one millisecond with 3% uncertainty are possible. Space and time resolution are limited by the x-ray intensity available. (auth)

27096 (ANL–7100, pp 217-45) INSTRUMENTATION FOR TWO-PHASE METALLIC FLOWS. Balzhiser, Richard E.; Smith, Lowell R. (Michigan Univ., Ann Arbor. Liquid Metals Lab.).

Instrumentation for measuring pressure drop and void fractions in two phase metallic flows is discussed. A Taylor differential pressure gage was used to measure pressure drop over a 36-in. length of horizontal 0.495-in. tubing. Void fractions were determined at the center of this section using radiation attenuation techniques. A thulium-170 source is used to provide a 0.084 Mev gamma ray for measurement purposes. A thallium activated NaI crystal is used for detection of the essentially monoenergetic beam. Problems in alignment at loop temperatures are cited as well as the importance of temperature control

of the scintillator. The range of applicability of such measurements and results obtained are discussed. (auth)

27097 (ANL–7100, pp 247-69) AN ACCURATE ONE-SHOT GAMMA ATTENUATION TECHNIQUE FOR MEASURING VOID FRACTIONS. Ferrell, J. K.; McGee, John W. (North Carolina State Univ., Raleigh).

The investigation to improve the accuracy of the one-shot technique for measuring local void volume fractions of two-phase fluids in small flow channels by eliminating the dependence of the measurements on the void distribution in the flow channel is described. It is concluded that the shape of the collimator used in the one-shot technique greatly affects the dependence of the void fraction measurements on the void distribution in the flow channel, and that the criterion given for designing a one-shot collimator will provide accurate void fractions measurements independent of the void distribution. Caution should be used in extending this method to situations where the average attenuation is greater than about 20% or to larger diameter flow channels. (W.L.G.)

27098 (ANL–7100, pp 271-87) DEVELOPMENT OF ALKALI METAL QUALITY METER. Tauson, Peter; Ammon, R. L. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.).

The measurement of the quality of alkali metal vapor involves two major goals: collection of a representative sample, and measurement of the sample quality. The first is a study in itself because of the tendency of alkali metal liquids to adhere to the walls. The second is the analysis of the quality of vapor of a collected sample. This paper deals primarily with the second goal. The method used is to measure the amount of energy required to dry the sample and compare it with the amount of energy required to superheat the sample to a preset amount of superheat ΔT. Fundamentally, two equations are involved: $H_1 = W(1 - x)\lambda$, and $H_2 = WC_p\Delta T$. Solving for quality x: $x = 1 - (C_p/\lambda)\ [(H_1/H_2)\Delta T]$. The actual form is somewhat more complex due to thermal and flow characteristics: however, an instrument can be constructed to provide the measurements of quality. (auth)

27099 (ANL–7100, pp 483-98) A METHOD FOR THE DETERMINATION OF LOCAL HEAT FLUXES IN LIQUID METAL HEAT EXCHANGERS. Stein, Ralph P. (Argonne National Lab., Ill.).

A new method is presented for the determination of local heat fluxes and fully developed local overall heat transfer coefficients in liquid metal or laminar flow double-pipe heat exchangers. The method uses measurements of outer wall temperature distributions and inlet and outlet fluid temperatures. Possible application to liquid cooled or heated condensers or boilers is discussed. (auth)

27100 (ANL–7100, pp 499-512) EXISTENCE OF NON-EQUILIBRIUM, INVERSE TEMPERATURE PROFILE IN BOILING TWO-PHASE FLOW. Chen, John C. (Brookhaven National Lab., Upton, N. Y.). (BNL–9296).

Experimental results indicate the presence of an inverse temperature profile in boiling liquid-metal, two-phase flow. This phenomena can be caused by a nonequilibrium condition in the vapor core which is accentuated by high pressure drop, a steep vapor temperature-pressure curve, and high velocity-high slip flow. Such an inverse profile is sufficiently different from the normally assumed picture heretofore that it can have an important bearing on the understanding and general theory of convective boiling. (auth)

27101 (ANL–7100, pp 549-71) SODIUM BOILING HEAT TRANSFER AND HYDRODYNAMICS. Lurie, Henry (Atomics International, Canoga Park, Calif.).

Results of experiments on the steady-state pool boiling critical heat flux of saturated sodium as a function of pressure, and on the forced convection boiling heat transfer characteristics and the critical heat flux of sodium as functions of pressure, flow rate, and subcooling or quality are reported. Also presented are the steady state two-phase pressure drop and void fraction results for the upflow of sodium in an unheated annulus. (W.L.G.)

27102 (ANL–7100, pp 573-632) RECENT DEVELOPMENTS IN HEAT TRANSFER AND DEVELOPMENT OF THE MERCURY BOILER FOR THE SNAP-8 SYSTEM. Sellers, A. J.; Wong, M. K. (Aerojet-General Corp., [Azusa, Calif.]); Thur, G. M. (National Aeronautics and Space Administration, [Washington, D. C.]).

The major requirements associated with mercury once-through boilers for space powerplants are repeatable startup and reliable long-term heat-transfer performance without deleterious effects on other system components such as turbines, pumps, and condensers. There have been a number of instances where mercury boilers were known to decondition either during startup or after some period of operation. The connotation is that any performance in the direction of providing poorer heat-transfer performance than expected, from either design correlations or some minimum accepted performance, is termed deconditioning, while any trend providing improved performance after initial thermal equilibrium is termed conditioning. This condition of performance uncertainty during system startup and endurance operation can cause performance reduction, prevent adequate startup, and precipitate turbine corrosion/erosion. Experimental data were evaluated to determine the validity of proposed semiempirical boiling heat transfer and two-phase flow pressure drop correlations, and boiling conditioning effects. A summary evaluation of these results are: The initial boiler performance characteristics are dependent on the mercury flow passage internal wall surface conditioning state and the thermal and dynamic conditions imposed by the flow passage internal geometry. High-velocity liquid-phase vortex flow at the preheat section end point combined with similar dynamic conditions in the low-vapor-quality section demonstrate excellent boiler conditioning effects when the mercury flow passage is cleaned by established methods prior to mercury injection. The boiling heat-transfer rates obtained from a fully conditioned boiler are in close agreement with the predictions established by the dropwise drywall boiling heat-transfer correlations. The two-phase flow pressure drop data are correlated by means of the product (ϕf_v) in terms of a modified Martinelli parameter. The introduction of a tight preheat section plug-insert geometry providing high liquid velocity also improved the boiler performance stability very significantly. Mercury inventory variations were minimized with tight plug-insert geometry. (W.L.G.)

27103 (ANL–7100, pp 633-40) X-RAY MOVIE FILM REPORT OF FLOW PATTERNS IN A ONCE-THROUGH FORCED CIRCULATION NaK-HEATED MERCURY BOILER. Ziobro, R. J. (TRW Equipment Labs., Thompson Ramo Wooldridge Inc., Cleveland, Ohio).

Films were presented that offered a visual insight into the two-phase flow liquid metal boiling process at temperatures and pressures where glass equipment cannot be used. A significant observation was made in the deconditioned state of the existence of a slug flow pattern. This flow regime was defined mathematically in a form suitable for boiler design analysis and performance evaluation. (W.L.G.)

27104 (ANL–7100, pp 641-65) HIGH TEMPERATURE LIQUID METAL INSTRUMENTATION AT ATOMICS INTERNATIONAL FOR: 1. THE SNAP 10A FLIGHT SYSTEM. 2. BOILER CONDITIONING EXPERIMENTS AND MERCURY VAPOR QUALITY MEASUREMENT FOR MERCURY RANKINE SYSTEMS. Hanlin, H. H. (Atomics International, Canoga Park, Calif.).

The instrumentation used to monitor the flow rate, pressure, and temperature of the K–Na liquid metal in the SNAP-10A flight system are described and the results of measurements made during orbit are given. Methods for calibrating a vapor radiation density detector used to measure mercury vapor quality are discussed. (W.L.G.)

27105 (BAW–3238-12) NONUNIFORM HEAT GENERATION EXPERIMENTAL PROGRAM. Quarterly Progress Report No. 11, January–March 1966. (Babcock and Wilcox Co., Lynchburg, Va. Atomic Energy Div.). Contract AT(30-1)-3238. 83p. (EURAEC–1629). Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Complete sets of data were obtained on four tubular test sections. One set had uniform flux to serve as a reference condition, and three had nonuniform axial heat flux to show the effect of flux distribution on critical heat flux conditions. These data were compared with those of other investigators where comparable data were available. Empirical correlations were developed to express mathematically the effects of the various operating variables on critical heat flux. Before the present report period, complete sets of data were obtained on three annular test sections. In the first case, the inside surface was heated, in the second the outside surface was heated, and in the third both surfaces were heated. Comparison with published burnout correlations revealed a need for improved correlations. During this report period, data were obtained on an annular test section with nonuniform flux on the outside surface and zero flux on the inside surface. Additional data were obtained with nonuniform flux on the outside surface and uniform flux on the inside surface. (auth)

27106 (EURAEC–1535) THEORETICAL PRESSURE AND PHASE DISTRIBUTIONS IN TWO-PHASE FLOW. Special Report No. 1. Bradfute, John O. (Maschinenfabrik Augsburg-Nuernberg A. G., Nuremberg (West Germany)). Nov. 1963. Contract 057-61-RDD. 71p. (EUR–2684). Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Six first order differential equations which simultaneously represent two phase flow in straight circular channels of constant cross section with or without heat addition are derived. These six equations are written in terms of six dependent variables; pressure, mixed mean liquid temperature, void fraction, quality, and two newly defined profile parameters. The derivation is based on the radially integrated average values of the four commonly used dependent variables; pressure, temperature, void fraction and quality. The profile parameters relate, for both phases separately, the radially integrated momentum to the product of mass flow rate times the radially integrated velocity. Length of the channel is regarded as the independent variable. Analytical solution of the set of equations appears impractical and programming for numerical solution by electronic computers is recommended. (auth)

27107 (GEAP–5142) A PROGRAM OF TWO-PHASE FLOW INVESTIGATION. Quarterly Report No. 12, January–March 1966. Staub, F. W.; Zuber, N. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Apr. 1, 1966. Contract AT(04-3)-189. 45p. (EURAEC–1628). Dep. mn. CFSTI $2.00 cy, $0.50 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

The experimental data at oscillating heat input and at a reduced pressure of 0.4 was completed in this period. Power oscillation amplitudes were at 25% and 40%, respectively, in a 0.05 to 10 cps frequency range. The percent of test section length required to remove inlet subcooling, based on thermodynamic equilibrium, was varied from 3% to 70%. Only a few runs were carried out with large inlet subcooling in order to acquire such data for future reference, as well as to indicate the order of magnitude effects of inlet subcooling on the dynamic behavior of the two-phase flow at this reduced pressure. The experimental dynamic void behavior is compared with the solution obtained from the propagation equation. The same comparison is thus made at a reduced pressure of 0.4 as was previously given at lower reduced pressures. A general method of analysis was developed to test for the stability of a two-phase system. Since stability criteria consisting of groups of independent variables will result from this formulation, they will first be compared to data with and without relative phase velocity to find whether these criteria are significantly affected by the relative velocity. If the present experimental rig can obtain information against which these criteria can be tested, recommendations for some revision of the planned test program will be made. (auth)

27108 (GEAP–5146) TRANSITION BOILING HEAT TRANSFER PROGRAM. Quarterly Progress Report No. 13, January–March 1966. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Apr. 1, 1966. Contract AT(04-3)-189. 18p. (EURAEC–1627). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Conceptual design of test equipment and instrumentation to measure heat transfer coefficients and steam phase superheat levels was started. Preliminary analysis of heat transfer from steam to droplets is presented, which can explain the very large evaporative heat transfer coefficients that have been inferred from experiments. (auth)

27109 (ORNL–TM–1311) A STUDY OF THE WALL COOLING DUE TO TANGENTIAL INJECTION OF A FLUID AROUND THE PERIPHERY OF AN AXIALLY SYMMETRIC JET [Thesis]. Craven, C. W. Jr. (Oak Ridge National Lab., Tenn.). [1962]. Contract W-7405-eng-26. 74p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Submitted to Tennessee Univ., [Knoxville].

An analytical and experimental study was made of the film cooling attainable with tangential injection of a fluid around the periphery of an axially symmetric jet. Both the cold injected stream and the hot primary stream were water. A postulate was made as to the conditions of flow, expressed as the core to annulus volumetric flow ratio, that would yield the optimum cooling efficiency. Based on the postulate, an analytic analysis was made which predicted the core-to-annulus volumetric flow ratio which would maximize the cooling efficiency. The cooling efficiency was defined as a dimensionless temperature ratio called the cooling effectiveness, and experimental data was taken to determine the dependence of the cooling effectiveness on the volumetric flow ratio. Velocity profiles were measured as they developed downstream of the points of injection for several core-to-annulus volumetric flow ratios. (M.O.W.)

27110 (WANL–TME–967) A PROGRAM FOR STEADY-STATE FLUID FLOW AND HEAT CONDUCTION. COUPLED CALCULATIONS OF HEAT-GENERATING SOLIDS COOLED BY PARALLEL CHANNELS, USING THE MCAP AND TOSS CODES. Lee, A. Y. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Oct. 1964. Contract SNP-1. 50p. Dep. mn. CFSTI $3.00 cy, $0.50 mn.

A method is developed for the calculation of the steady state fluid flow distribution, temperature rise, and pressure drop of a coolant and the material temperature distribution of a heat generating solid. The heat generating solid is cooled by flow along uniform parallel channels and can be arbitrary in geometry. The heat generating rate can be nonuniform and the cooling channels can be either cooling holes or annuli. A computer program and its application to this problem are described. (auth)

27111 (BNL-tr–6) SHORT SURVEY OF THE AVAILABLE DATA. (LIQUID-METAL HEAT EXCHANGE IN A VERTICAL TUBE AT LOW VALUES OF THE PECLET NUMBER). Ampleev, N. A.; Kirillov, P. L.; Subbotin, V. I.; Suvorov, M. Ya. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Tekhnicheskii Institut). Translated by S. Amoretty (Brookhaven National Lab., Upton, N. Y.). 58p. Dep. mn; CFSTI $3.00 cy, $0.75 mn; JCL $5.60 fs, $1.94 mf.

Studies were made to determine the reason for different results that have been obtained on heat exchange at low Peclet numbers and the theoretical values Nu = 4.36 have yielded. The object was to determine the length of the initial thermal section dependent on the Peclet number for the turbulent flux. The experimental results in the laminar region, produced a value of the Nusselt number higher than 4.36. This difference from the theoretical value is due to natural convection. Two methods for determining heat emission in Na–K flow produced close results at Pe < 100, which indicates a lack of significant contact thermal resistance in the considered conditions (the oxygen content in Na–K is 3×10^{-3} to 5×10^{-4}% by weight). (P.C.H.)

27112 INFLUENCE OF A TRANSVERSE MAGNETIC FIELD ON FORCED CONVECTION LIQUID METAL HEAT TRANSFER. Gardner, R. A.; Uherka, K. L.; Lykoudis, P. S. (Purdue Univ., Lafayette, Ind.). AIAA (Amer. Inst. Aeron. Astronaut.) J., 4: 848-52(May 1966).

Liquid mercury flowing through a stainless steel tube 17.5 in. in length and 0.180 in. in diameter was subjected to a uniform radial heat flux over the final 9.6 in. of the tube's length for a range of Reynolds numbers from 9,600 to 137,000. It was found that a transverse magnetic field of about 10,000 gauss inhibited the convective mechanism of heat transfer. No appreciable influence of the field was observed at the lower limit of the Reynolds numbers because the convective mechanism then is overshadowed by the strong thermal conductivity of mercury. At higher Reynolds numbers where the convective mechanism is significant, the electromagnetic force competes with the inertia force and, in effect, tends to damp out the vigorous fluctuations that enhance the convective mechanism. The inhibition of the convective mechanism is illustrated graphically by a 20 to 30% decrease in the Nusselt number. The influence of the magnetic field at the upper limit of Reynolds numbers investigated was found to diminish as the inertia force began to overpower the electromagnetic force. (auth)

27113 MECHANISM FOR BUBBLE FORMATION DURING BOILING. Shekriladze, I. G. Soobshch. Akad. Nauk Gruz. SSR, 41: 391-8(Feb. 1966). (In Russian).

In view of the contradictory results of studies on the bubble formation during boiling, an attempt was made to clarify the role of phase changes within the bubbles formed at the heated wall surface. A new physical model of the process was developed, explaining satisfactorily the available experimental results. Originally it was assumed that the heated surface is cooled by the evaporation of a microlayer of the liquid involved in the formation of the bubble. Subsequent experiments revealed that after the formation of the bubble the surface temperature first drops suddenly then it regains its maximum value after the separation of the bubble from the wall; the old theory required that the wall be cooled by mass of colder liquid replacing the bubble. The study revealed that evaporation at the bubble surface is of nonuniform character, resulting in a decrease of the surface tension in the direction from the base toward the sides of the bubble. The tangential forces thus created cause a circulation of the liquid and gas phases; the amount of liquid passing through the bubble while it is in contact with the wall was estimated at three orders of magnitude larger than the bubble's own volume. This heat transfer mechanism in the boundary layer is the most important factor in the heat transfer under conditions of nucleate boiling, exceeding the effect of surface tension itself. (TTT)

27114 RECENT DEVELOPMENTS IN LIQUID-METAL HEAT TRANSFER. Dwyer, O. E. (Brookhaven National Lab., Upton, N. Y.). At. Energy Rev., 4: 3-92(1966). (BNL-9597).

Developments in liquid-metal heat transfer are reviewed. Comparisons between theoretical and empirical predictions and experimental results, with accompanying discussions are presented. Areas where further research is needed are indicated. Emphasis is given to those topics of most engineering interest. The principal topics covered include liquid-metal heat transfer for: flow in pipes, flow in annuli, flow between parallel plates, in-line flow through rod bundles, 90° cross flow through rod bundles, oblique flow through rod bundles, pool boiling, natural-convection boiling in a recirculating loop, forced-convection boiling in a recirculating loop, and critical heat flux in both pool and forced-convection boiling. (100 references.) (auth)

27115 HEAT-TRANSFER EFFECTS ON THE DEVELOPING LAMINAR FLOW INSIDE VERTICAL TUBES. Lawrence, W. T. (Massachusetts Inst. of Tech., Cambridge); Chato, J. C. J. Heat Transfer, 88: 214-22(May 1966).

A numerical method was developed for the calculation of entrance flows in vertical tubes for the cases of upflow or downflow and constant wall heat flux or constant wall temperature. The solutions were in excellent agreement with experimental data obtained with water flowing upward in a vertical heated tube. The results show that both the density and the viscosity have to be treated as nonlinear functions of temperature. Consequently, for the constant heat flux condition, the velocity and temperature profiles constantly change and never reach "fully developed" states. The transition to turbulent flow was also studied. The experimental measurements demonstrated that the transition process depends on the developing velocity profiles. For the constant heat flux case, transition will always occur at some axial position. For a given entrance condition, the distance to transition is fixed by the fluid flow rate and the wall heat flux. For the experimental results, a tentative transition criterion was obtained, which depends only on the velocity profile shape, fluid viscosity, and the entrance Reynolds number. (auth)

27116 THERMAL CALCULATIONS FOR ROD BUNDLE ELEMENTS FOR NUCLEAR REACTORS. Markoczy, G. (Eidgenoessische Institut fuer Reaktorforschung (EIR), Wuerenlingen, Switzerland). Neue Tech., 8: 31-46(Feb. 1966). (In German).

A method of calculating heat transfer in gas-cooled or superheated steam-cooled rod clusters is outlined. The thermodynamic characteristics of rod clusters are discussed, together with some results that were obtained using this method. (D.C.W.)

27117 THERMAL STRESSES IN A FINITE HOLLOW CYLINDER DUE TO AN AXISYMMETRIC TEMPERATURE FIELD AT THE END SURFACE. Iyengar, K. T. Sundara Raja; Chandrashekhara, K. (Indian Inst. of Science, Bangalore). Nucl. Eng. Design, 3: 382-93(Apr. 1966).

A three-dimensional exact solution for determining the thermal stresses in a finite hollow cylinder subject to a steady state axisymmetric temperature field over one of its end surfaces was given. Numerical results for a hollow cylinder, having length to outer diameter ratio equal to one and inner to outer diameter ratio equal to 0.75, subjected to a symmetric temperature variation over the end surfaces of the cylinder were given. (auth)

27118 SOME PROBLEMS ON NONISOTHERMAL STEADY FLOW OF A VISCOUS FLUID. Bostandzhiyan, S. A.; Merzhanov, A. G.; Khudyaev, S. I. Zh. Prikl. Mekh. Tekh. Fiz., No. 5, 45-50(Sept.-Oct. 1965). (In Russian).

Three problems of unforced flows are studied: flow between two parallel plates, flow in an annular space between two infinite cylinders (axial flow), and flow between two rotating cylinders with account of energy dissipation and the variation of viscosity with temperature given in the Reynolds' equation $\mu = \mu_0 \exp(-\beta T)$. Two types of boundary conditions are considered: on both surfaces the constant (and, in the general case, unequal) temperatures are given; and the constant temperature on one surface is given, and heat exchange with the surrounding medium occurs through the other. Some special cases such as the case of equal cylinder temperatures and the insulation of one cylinder are discussed. A means of computing the torsional moment due to friction is given for the flow between two coaxial cylinders. (ATD)

27119 HEAT EXTRACTION SYSTEM WITH CONCENTRICALLY RUNNING GAS DUCTS BETWEEN THE NUCLEAR REACTOR AND THE POWER CONSUMPTION UNIT. Fortescue, Peter (to General Dynamics Corp.). German Patent 1,213,068. Mar. 24, 1966. Priority date Feb. 10, 1961, United States.

A gas turbine unit is disposed within the inner duct of the concentric ducting arrangement, and a compressor unit is mounted within the outer duct of the concentric ducting system in concentric relation with the turbine unit, the compressor having rotor and stator blades formed integrally with the rotor and stator blades of the turbine unit so that the driven turbine effects the simultaneous driving of the

compressor unit whereby cooled gas passing through the outer duct is compressed to provide the necessary circulation rate. A single rotating member carries the integral rotor blades of the turbine and the compressor unit. (Gmelin Inst.)

Materials Testing

27120 (BNWL-SA-646) NUCLEAR TECHNIQUES IN NONDESTRUCTIVE TESTING. Jackson, Charles N. Jr. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 1966. Contract AT(45-1)-1830. 21p. (CONF-660526-1). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From International Standards Assn., Northwest Instrument Conference and Exhibit, Richland, Wash.

Three nuclear systems are described for nondestructive testing: a gamma spectrometer; an alpha counter; and an x-ray fluorescence method. A single channel analyzer combined with a gamma scintillation detector system was developed to monitor the enrichment of ^{235}U in uranium fuel elements. With a gamma count of 2 min the test system has an accuracy of about 0.1 wt % over a 0.05 to 3.0 wt % enrichment range. An alpha scintillation counter with an accuracy of about 25% at the 100 microgram contamination level was developed to test production fuel elements for uranium as a surface contaminant. The x-ray fluorescence investigation established that variations of the weld surface limited the threshold of sensitivity for detecting uranium as a possible contaminant. The prototype measured uranium contamination over a range from about 2 to 10 wt % when testing a small volume (0.25×10^{-3} in^3) at a scan rate of 5 in./min. (P.C.H.)

27121 (NP-15961) GAMMAGRAFIE, EEN METHODE VOOR NIET-DESTRUCTIEF ONDERZOEK. (Gammagraphy—A Method for Nondestructive Testing). Cattel, J. J. P.; de Sterke, A.; Eering, J. Th. (Nederlands Atoomforum, The Hague). [nd]. 37p. Dep. mn.

Three articles on the use of gammagraphy for the nondestructive testing of materials are presented. The topics discussed are the significance of radiation testing in industry, possibilities and limitations of gammagraphy with radioisotopes, and radiation production in industrial radiography. (J.S.R.

27122 (Y-KE-194) INDUSTRIAL INTERFEROMETRY. Whitten, L. G. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Apr. 22, 1966. Contract W-7405-eng-26. 44p. (CONF-651072-1). Dep. mn. CFSTI $2.00 cy, $0.50 mn.

From American Society of Tool and Mfg. Engineers, Chapter 107, Knoxville, Tenn.

An introduction to interferometry and wave interference effects is presented. Light sources for interferometric measurements are discussed. Industrial uses of interferometric measurements are described. (M.O.W.)

27123 STEADY-STATE STRESSES IN CONCRETE STRUCTURES SUBJECTED TO SUSTAINED TEMPERATURES AND LOADS. PART II. CASES OF THREE DIMENSIONAL STRESS: HOLLOW CYLINDER AND HOLLOW SPHERE. England, G. L. (King's Coll., London). Nucl. Eng. Design, 3: 246-55(1966).

Theory is presented for the calculation of steady-state stresses resulting from creep in a thick sphere and a long-thick cylinder subjected to sustained temperature and pressure loading, as may occur in prestressed concrete reactor pressure vessels. Two numerical examples are included, and for comparison, the stresses as calculated by conventional elastic theory are shown also. These initial stresses resulting from pressure and temperature loading and the steady-state stresses which result from differential creep form upper and lower bounds. Shown also are the important stresses which may result when a structure is cooled after a long period of service. Finally, theory which is applicable to the general three-dimensional stress system is postulated. (auth)

27124 A THEORETICAL AND EXPERIMENTAL INVESTIGATION OF THE STRESSES IN A CIRCULAR CYLINDRICAL SHELL WITH AN OBLIQUE EDGE. Corum, J. M. (Oak Ridge National Lab., Tenn.). Nucl. Eng. Design, 3: 256-80(1966). (ORNL-P-1892).

The stresses in a circular-cylindrical shell clamped along an oblique edge and subjected to internal pressure and to three mutually perpendicular moments and perpendicular forces applied at the free end were examined theoretically and experimentally. The theory was based on the assumption that the total stress state could be approximately determined as the sum of a membrane stress state, a pure bending stress state, both of which were determined by the membrane theory, and an edge effect. This approximation is valid only for a sufficiently thin shell. To investigate the applicability of the theory to a relatively thick shell with a large angle of inclination, an epoxy resin model, which had a radius-to-thickness ratio of 15 and was inclined at an angle of 45°, was instrumented with strain gages and tested with the same loadings that were analyzed theoretically. Theoretical and experimental stresses were then compared. The agreement between the theory and experimental results was reasonably good for the majority of the loadings even though the bounds of the theory were knowingly exceeded. For three of the loadings the predicted edge effect at one of the three circumferential locations examined was erroneous. The error actually was in the membrane theory, upon which the edge effect depended, and it was due to the shell of the experimental model being too thick for the membrane theory to be applicable. For a sufficiently thin shell, the theory would be expected to yield acceptable results for all seven loadings. (auth)

Protective Structures

27125 (UCRL-14848-T) AIR BLAST PROTECTION IN TUNNELS. Viecelli, James (Lawrence Radiation Lab., Univ. of California, Livermore). Mar. 30, 1966. Contract W-7405-eng-48. 32p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

The motion of a blast wave in a blind straight tunnel, a sharp right angle bend, a T intersection, a blind T intersection, a constriction or throat, and a region of energy removal is described. It was found that either a system of blind T intersections or a set of throats or a combination of both offer protection against strong blast. The throat system is discussed in detail. Spacing between throats, length of throat, cross section area of throat, and strength of blast in relation to protective ability is covered including approximate methods of calculating the relevant parameters. (auth)

27126 DOSE ATTENUATION IN TWO-LEGGED CONCRETE DUCTS FOR VARIOUS GAMMA-RAY ENERGIES. Chapman, J. M.; Huddleston, C. M. Nucl. Sci. Eng., 25: 66-74(1966).

Methods are outlined for computer calculation of first- and second-order contributions to gamma-ray dose rates in two-legged rectangular concrete ducts of personnel shelters. Four computer programs, based on values of differential dose albedo derived from Monte Carlo calculations, are used to calculate corner-lip inscattering, backscattering from surfaces visible to both source and detector, and combinations of these two scattering events. The first program computes the dose contribution from corner-lip inscatter and from combinations of corner-lip penetration and wall backscatter. The second calculates first-order backscatter from the basic scattering areas in the corner of the duct. The third computes the second-order backscatter contribution from two successive backscatters from the duct walls. The final program calculates the contribution due to combinations of one wall backscatter and one corner-lip inscatter. The results of the calculations are compared with experimental results obtained by several investigators. The experimental studies used 11 × 11-in., 3 × 3-ft, and 6 × 6-ft ducts; the gamma-ray sources were, variously, ^{198}Au, ^{137}Cs, ^{60}Co, and ^{24}Na. Since the difference between calculated and measured values of gamma-ray dose in the second leg is generally less than 30%, results obtained by calculation can be used to predict

the attenuation factors of two-legged concrete ducts and entranceways leading into personnel shelters with an expected error of less than 30%. (auth)

27127 FALLOUT SHELTER ARRANGEMENT. Smith, Tom R. (to American Air Filter Co., Inc.). U. S. Patent 3,242,844. Mar. 29, 1966. Filed Jan. 27, 1964.

A fallout shelter is provided with an associated filter chamber positioned in spaced relationship from the personnel enclosure of the shelter to insure that contaminated particles are removed from the atmospheric air before it enters the personnel shelter. Provision is also made for the protection of the filtering equipment from sudden atmospheric pressure variations due to bomb blast. A filter bank of spaced unit filters is supported in the filter chamber in readily replaceable fashion to facilitate loading and changing the filter equipment. (B.L.M.)

Space Propulsion

See also **ISOTOPE TECHNOLOGY — Power Application**
REACTOR TECHNOLOGY — Propulsion and Space

27128 (ANL–7100, pp 127-64) DEVELOPMENT OF EFFLUX MEASURING DEVICE FOR PERFORMANCE EVALUATION OF POTASSIUM VAPOR TURBINE. Wesling, G. C.; Rossbach, R. J. (General Electric Co., Cincinnati, Ohio. Space Power and Propulsion Section); Shaffernocker, W. M. (General Electric Co., Cincinnati, Ohio).

The pressure measuring device (efflux) that was developed is based on flowing a metered amount of an inert gas through the sensor lines into the test facility. The flow of inert gas into the test facility prevents the diffusion of potassium vapor into the sensor lines. By this technique the potassium vapors can be contained within the facility and pressure transducers, which operate in an inert gas, moderate temperature environment can be used for the measurements. The device was developed by making tests with air, steam, and potassium vapor. When fully developed, the efflux measuring device was used to measure total and static pressures in the two-stage 200-hp potassium turbine at inlet and outlet, and the static pressures between all blade rows. In addition, an important application of this device was the measurement of potassium vapor flow rate by means of the measurement of total and static pressures in the calibrated annulus ahead of the potassium vapor turbine. The efflux pressure measuring device may work equally well in the measurement of the pressure alkali metal vapors other than potassium. (auth)

27129 (ANL–7100, pp 291-306) LIQUID-METAL LUBRICATED BEARING INSTRUMENTATION. Grieser, D. R. (Battelle Memorial Inst., Columbus, Ohio); Morris, J. L. (Air Force Aero-Propulsion Lab., Wright-Patterson AFB, Ohio).

The development of instrumentation to permit measurement of the thickness, pressure, and continuity of liquid metal lubricant films is described. Techniques were selected that can directly measure the film with a minimum perturbation of the film and the bearing behavior. Miniaturized transducers are required to facilitate the measurement of film thickness and pressure profiles within a single bearing. The capability for being hermetically sealed is necessary to resist attack by the liquid-metal environment. A capability for operating at elevated temperatures without cooling is desired so that the normal thermal environment of the bearing is not altered. Two techniques were selected as having the potential for most closely meeting the desired characteristics. An eddy-current/inductance technique was chosen for the measurement of film thickness and detection of film continuity. A technique based on the Villari effect was chosen for the measurement of film pressure. (W.L.G.)

27130 (ANL–7100, pp 307-29) DEVELOPMENT OF PERFORMANCE-MEASURING INSTRUMENTATION FOR A LIQUID-METAL TURBINE-DRIVEN BEARING TEST RIG. Stillwell, L. W.; Herman, R. (Garrett Corp., Phoenix, Ariz. AiResearch Mfg. Div.).

A film thickness measuring system based on eddy currents was designed and developed. The basic device consisted of two coils mounted diametrically opposite each other on each side of the journal shaft. Correspondence between film thickness in the journal bearings and motion of the journal was obtained from a knowledge of the journal and bearing dimensions. (W.L.G.)

27131 (ANL–7100, pp 331-64) APPROACHES TO THE MEASUREMENT OF THE STEADY-STATE AND DYNAMIC PERFORMANCE CHARACTERISTICS OF LIQUID-METAL LUBRICATED BEARINGS. Arwas, E. B.; Orcutt, F. K.; Sternlicht, B. (Mechanical Technology Inc., Latham, N. Y.).

A discussion of the instrumentation necessary for fundamental investigations, as well as for bearing development and for monitoring of bearing performance in turbomachinery is presented. It points out through examples, that considerable advances applicable to liquid metal lubrication can be accomplished with easy to use fluids that simulate some of the important properties of liquid metals and making use of instrumentation that is already developed. Indirect measurements which, in conjunction with accepted theoretical relations, provide meaningful interpretation of bearing performance are also discussed. (auth)

27132 (LA-DC–7655) DESIGN, ANALYSIS, AND PERFORMANCE OF AN EXPERIMENTAL LIQUID HYDROGEN–WATER HEAT EXCHANGER. Bartlit, J. R.; Henshall, J. B.; Nutter, M. J.; Rink, J.; Williamson, K. D. Jr. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [1966]. Contract W-7405-eng-36. 20p. (CONF-660608–1). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From 2nd AIAA Propulsion Joint Specialist Conference, Colorado Springs.

A 160-ft long liquid hydrogen-water heat exchanger was designed, built, and tested. It consisted of two 80-ft passes, comprising a 4.06-in. ID finned aluminum pipe inside a $9\frac{1}{2}$-in. ID outer pipe. Hot water (the heat source) flowed in the outer jacket countercurrently to the hydrogen in the inner line. The outlet hydrogen gas was used, in part, to drive the turbine of the liquid hydrogen pump which supplied the heat exchanger with liquid. Tests were made at hydrogen flow rates up to 15 lb/sec with pressure levels up to 1000 psi. The outlet gas temperature at the high flow rates was 260°R. Tests revealed a problem of large flow and pressure oscillations in the system. A simple dynamic model explaining this behavior and a method of stable operation suggested by the model are described. This method was successfully used. Hydrogen heat transfer coefficients were obtained. These were in general 60% of the values predicted from the Dittus-Boelter equation. In an effort to improve the hydrogen heat transfer, a twisted tape swirl inducer was included in one of the passes. This gave coefficients that were 90% of those predicted by the Dittus-Boelter equation. Experimental axial temperature gradients were compared to those predicted by means of analog and digital methods. Fin efficiencies and strain data were obtained. (auth)

27133 (LA-DC–7656) STABILITY OF GAS FLOW DISTRIBUTION AMONG PARALLEL HEATED CHANNELS. Bankston, C. A.; Sibbitt, W. L. (Los Alamos Scientific Lab., Univ. of California, N. Mex.); Skoglund, V. J. (New Mexico Univ., Albuquerque). [1965]. Contract W-7405-eng-36. 39p. (CONF-660608–2). Dep. mn. CFSTI $2.00 cy, $0.50 mn.

From 2nd AIAA Propulsion Joint Specialist Conference, Colorado Springs.

The nature of heat transfer and fluid mechanics of turbulent laminar transition flows and their relation to the problem of flow distribution stability was investigated. Normal hydrogen gas entered a uniformly heated tube at Reynolds numbers from 600 to 13,000 and was heated to temperatures up to 8.9 times the entering temperature. The use of local correlations for friction factors generally resulted in the prediction of higher stable exit-to-inlet temperature ratios than previous calculations which assumed fully developed flow. Calculations for a typical

channel of a nuclear rocket core with change of area and nonuniform heating showed that the entrance impedance of the channel more than compensated for the destabilizing effect of nonuniform heating. At an entrance Reynolds number of 2350, the core configuration should exhibit stable flow distribution for exit-to-inlet temperature ratios less than 10, whereas the limit for an equivalent uniformly heated, unimpeded channel is 7. (P.C.H.)

27134 (SC-CR-66-2015) BOOSTER ROCKET ALTITUDE ABORT PROGRAM. Second Quarterly Progress Report for Period Ending January 4, 1966. Ottinger, R. S.; Van Nice, L. J. (TRW Systems, Redondo Beach, Calif.). Contracts AT(29-1)-789; 48-2223. 42p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

For Sandia Corp., Albuquerque, N. Mex.

A theoretical model was developed to describe the launch-abort environment. Data from experimental work are used to establish major parameters and their quantitative relationships for application to the model to be used for fireball predictions. (auth)

27135 ANALYTICAL AND EXPERIMENTAL PERFORMANCE OF CAPACITOR-POWERED COAXIAL PLASMA GUNS. Michels, C. J.; Heighway, J. E.; Johansen, A. E. (Lewis Research Center, Cleveland). AIAA (Amer. Inst. Aeron. Astronaut.) J., 4: 823-30(May 1966).

Experimentally derived calorimetric exhaust efficiencies are compared with efficiencies predicted from a snowplow-model analysis. Four geometries are studied for a range of initial masses and voltages. Variation of kinetic efficiency with a mass-loading parameter, parasitic inductance, and mass distribution is examined. For a simplified case in which drag, radiation, and ionization losses are not considered, optimum values for the first two of these parameters are nearly constant over a practical range of mass distributions. The kinetic efficiency for these optimum values theoretically increases monotonically from 27 to 93% as the mass distribution is varied from uniform to that of a slug. Experimentally stable operation of a gun has been limited to mass distributions for which the simplified analysis limits efficiency to about 40%. Experimentally measured efficiencies for properly operating guns are approximately half those predicted with the simplified analysis. The simplified model is a special case of a more complete theory that is presented, but for which detailed calculations have not been made yet. Preliminary results for one of the geometries indicate that peak efficiencies predicted are about 25% lower than those given by the simplified theory. (auth)

27136 QUASI-STEADY-STATE PULSED PLASMA THRUSTERS. Ashby, D. E. T. F. (General Dynamics Convair, San Diego, Calif.); Liebing, L.; Larson, A. V.; Gooding, T. J. AIAA (Amer. Inst. Aeron. Astronaut.) J., 4: 831-5(May 1966).

It is proposed that in d–c plasma thrusters, which accelerate plasma by the interaction of the discharge current and its magnetic field, the input power is proportional to the cube of the exhaust velocity. For velocities of 10^4 to 10^5 m/sec, powers of the order of 10^2 to 10^4 kw are indicated. The mean power level can be reduced, and the thruster can be operated into a hard vacuum (10^{-6} torr) without a gigantic pumping system if the discharge current and propellant are pulsed. Experiments with a pulsed arc thruster are described. The thruster is powered by a lumped parameter pulse line of a several hundred microseconds period; hydrogen, nitrogen, and argon propellants have been used. The arc characteristics are similar to the d-c magnetoplasmadynamic arcs. Exhaust velocities between 1 and 5×10^4 m/sec and thermal efficiencies between 15 and 25% are typical. Experimental difficulties arising from currents external to the thruster and from propellant adsorbed on the electrodes are discussed. The addition of an external magnetic field improves the symmetry of the discharge, reduces localized anode erosion, and increases the arc impedance by a factor of 2, but does not alter the thermal efficiency significantly. The magnitude of the total azimuthal Hall current is only 5% of the magnitude of the total radial current. (auth)

27137 CYCLOTRON RESONANCE THRUSTER DESIGN TECHNIQUES. Miller, David B.; Bethke, George W. (General Electric Co., King of Prussia, Pa.). AIAA (Amer. Inst. Aeron. Astronaut.) J., 4: 835-40(May 1966).

The most successful cyclotron-resonance accelerator designs have been of the longitudinal-interaction type. Quartz, alumina, sapphire, and beryllia have been employed at medium power (to 540 w, S band) and high power (to 4150 w, X band) to separate the evacuated plasma chamber from the remainder of the waveguide circuit. Sizable wall losses have been encountered, but the accelerator may be made sufficiently short so that an appreciable percentage of the rf power (up to 65% at X band) ultimately appears in the accelerated plasma stream. Peripheral gas injection has yielded better results than injection through a hole in the window because of window structure and rf coupling problems. This type of accelerator is assessed to have propulsion potentialities, particularly if the space system into which it is to be incorporated already has substantial rf capacity for communications purposes. (auth)

27138 TEST REQUIREMENTS OF ELECTRIC PROPULSION SYSTEMS LEADING TO EXTENDED FLIGHT TIME MISSIONS. Stearns, John W. Jr. (California Inst. of Tech., Pasadena). Contract NAS 7-100. J. Spacecraft Rockets, 3: 735-7(May 1966).

Test requirements, including feasibility and lifetime reliability demonstrations, for electric propulsion systems for mission lifetimes in the range of 5000 to 50,000 hr are discussed. Technological goals and minimum requirements of electric propulsion systems are presented. (B.G.D.)

27139 SURFACE IONIZATION ENGINE DEVELOPMENT. Ernstene, M. P. (Electro-Optical Systems, Inc., Pasadena, Calif.); James, E. L.; Purmal, G. W.; Worlock, R. M.; Forrester, A. T. Contract AF 33(615)-1530. J. Spacecraft Rockets, 3: 744-7(May 1966).

The development and performance of surface ionization engines of nominal 10 mlb size are discussed. The characteristics of ionizer and neutralizer components are presented. (B.G.D.)

27140 DETERMINATION OF THE VELOCITY OF AN ION BEAM FROM ITS SELF-FIELD. Bahr, Alfred (DFL-Institut fuer Strahlantriebe, Brunswick). Raumfahrtforschung, 10: 64-6(Apr.-June 1966). (In German).

The theoretical basis of a new speed measuring device for ion beams is described. The principle employed has the advantage that no probes, nozzles, ballistic plates, electrodes, etc., are placed inside the ion beam. Furthermore, the ion beam is not acted upon by superimposed fields generated by outside sources. Instead of the self-fields, that is the radial directed electric field and the tangential directed magnetic field outside the ion beam is utilized to determine the speed of the ion beam. The method is suitable theoretically up to relativistic speeds. (auth)

Vacuum Engineering

27141 SIMPLE PUMP FOR OBTAINING AN ULTRA-HIGH VACUUM. Nikolaenko, O. K.; Bulgakov, Yu. V.; Tikhomirov, M. V. (Scientific-Research Physicochemical Inst., Moscow). Prib. Tekh. Eksp., No. 6, 205-6(Nov.-Dec. 1965). (In Russian).

A titanium nitrate pump is described. It is made of glass and was designed for obtaining an ultrahigh vacuum of about 10^{-9} torr in a small limited space. The operation of the pump is based on the abnormal sorption of gases evaporated by titanium at temperatures lower than –170°C. A glass vacuum envelope with an interposed Kovar alloy connection was soldered to a flange made of stainless steel. A cross section of the pump is shown. A ball-shaped surface covered by a titanium film and cooled by liquid nitrogen (oxygen) serves as a pumping element. The electrically heated

spiral made of 0.7 mm molybdenum wire with a titanium coating is used as a titanium evaporator. The screen prevents the discharge of titanium into the vacuum. A valve separates the glass envelope from the other part of the vacuum system. The operation of the pump is briefly explained. The pump can operate during 100 hours without replacing the spiral. The consumption of liquid nitrogen was one liter per hour. (ATD)

GEOLOGY, METEOROLOGY, AND MINERALOGY

General

Refer also to abstracts 26787, 27193, and 28140.

27142 RECENT ADVANCES IN RADIOISOTOPE APPLICATIONS FOR EXPLOITATION OF PETROLEUM AND NATURAL-GAS RESERVOIRS. Armstrong, F. E.; Howell, W. D. (Bureau of Mines, Bartlesville, Okla). Isotop. Radiat. Technol., 3: 102-14(Winter 1965–1966).

Some of the more important recent advances in the application of radioisotopes to the exploitation of petroleum and natural-gas reservoirs are reported. Most references were published during the past 5 years, although in a few isolated instances earlier work was included for the sake of continuity and clarity. The uses of radioisotopes in injection and production profile work, well logging, and well-to-well tracers for reservoir evaluation and secondary recovery operations are discussed. Some applications of activation analysis are also reviewed. (auth)

27143 LOSS OF ARGON FROM BIOTITE IN A THERMAL METAMORPHISM. Westcott, M. R. (European Space Technology Centre, Holland). Nature, 210: 83-4 (Apr. 2, 1966).

An investigation was made of the diffusion of argon from the biotite of a mica schist due to the intrusion of a dyke. The activation energy of argon release was inferred from the diffusion process using a mathematical model, and is compared with that obtained in complementary laboratory experiments on the kinetics of argon release in a vacuum. (L.B.S.)

Meteorology

See also Site Survey and Selection

27144 (BNWL-SA–650) TRACE ELEMENT AND TRACE RADIONUCLIDE COMPOSITION OF SNOW AND RAIN. Perkins, R. W.; Engelmann, R. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 20, 1966. Contract AT(45-1)-1830. 20p. (CONF-660416–1). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From Pacific Northwest Metals and Minerals Conference, Seattle.

Measurement techniques, observed concentrations, and the origin of several trace materials that have been measured in rain and snow are described. The possible use of these natural materials plus the use of artificial tracers in describing atmospheric phenomena are considered. It was concluded that developments in multidimensional gamma spectrometry provide the required sensitivity and selectivity for measuring many of the tracers by direct counting. Trace element measurements of the residues from snow samples indicate that these residues and presumably the condensation nuclei are from the earth's crust rather than from sea spray. The low concentrations of the trace elements Sc, Ag, Co, and Sb in these residues show that these elements would be very sensitive tracers of atmospheric precipitation processes. (P.C.H.)

27145 (RISO–121) METEOROLOGICAL MEASUREMENTS AT RISOE, 1962–1964. Christensen, J. (Danish Atomic Energy Commission, Risoe. Research Establishment). Dec. 1965. 75p. Dep. mn.

Statistical information on the measurements of wind, temperature, and precipitation made from the meteorological tower at Risö is reported. Means, variations, frequencies, and profiles are presented in tables and/or in graphic form for the air layer from the ground to 123 m. The variations and frequencies of stability types and smoke-trail classifications are appended. (auth)

Natural Radioactivity and Fallout

See also HEALTH AND SAFETY

Refer also to abstract 26610.

27146 (AFRRI-CR-65-5) GAMMA-RAY ENERGY AND ANGULAR DISTRIBUTIONS NEAR THE AIR/GROUND INTERFACE FROM PLANE FALLOUT AND POINT ^{60}Co SOURCES. French, R. L. (Radiation Research Associates, Inc., Fort Worth, Tex.); Garrett, C. W. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). June 1964. Contract DA-49-146-XZ-254. 34p.

Monte Carlo techniques were applied in a detailed study of the gamma radiation environment three feet above the air/ground interface due to two types of gamma-ray sources: (1) fallout uniformly distributed on the ground surface, and (2) a ^{60}Co point source also three feet above the ground at separation distances of 100 to 800 feet. In each case, the scattered and direct-beam fluxes were computed in each of ten receiver energy intervals between 0.04 and 3.5 Mev and eighteen equal receiver angle intervals between 0° (nadir) and 180° (zenith). All results were integrated over azimuthal angle at the receiver to reflect distribution in polar angle only. The source energy was used as a parameter in the fallout calculations and the results thus computed for each of ten different source energies may be weighted and combined to obtain data for fallout of any desired age. Comparisons of the Monte Carlo data with measured data and with other calculated data, both for fallout and for ^{60}Co point sources, show favorable agreement. (auth)

27147 X-RAY SPECTROGRAPHIC DETERMINATION OF HAFNIUM–ZIRCONIUM RATIO IN ZIRCONIUM MINERALS. Abdel-Gawad, A. M. (Atomic Energy Establishment, Cairo). Amer. Mineral., 51: 464-73(Mar.-Apr. 1966).

Variations of zirconium and hafnium in zirconium minerals are highly significant in geochemical studies. Data on their relative abundance would be obtained if the ratio could be determined directly on mineral concentrates. A rapid method for determining hafnium and zirconium applied indestructively on zirconium mineral grains is described. It is based on calibrating peak intensity ratios against elemental ratios in standard samples. Analytical lines used are the first order $L_{\beta 1,6}$ doublet of hafnium and the second order doublet $K_{\beta 1,3}$ of zirconium. For intensity measurements the flow counter was found to be superior to the scintillation counter in reducing serious interference caused by $ZrK_{\beta 2}$ (second order) line. Optimum operating conditions required for maximum long-term reproducibility of ratios were determined. Stability of analytical line intensity ratios was attained at 44 to 48 kv tungsten tube potential and a flow counter high voltage 1500 to 1700 v. Examples of Hf/Zr ratios determined for a number of zircon varieties from the UAR are given. Values were found to be reproducible within 5% over a three month period without any need for recalibration. (auth)

27148 SOLID-SOURCE LEAD ISOTOPE MEASUREMENTS AND ISOTOPIC FRACTIONATION. Cooper, J. A.; Richard, J. R. (Australian National Univ., Canberra). Earth Planet. Sci. Lett., 1: 58-64(Mar. 1966).

Solid-source lead-isotope measurements were made with microgram quantities of lead oxalate. The resultant lead oxide-lead metal mixture showed an improvement on the more customary PbS load in that it produced larger beams which were more stable and yielded more reproducible results. Isotopic fractionation is shown to be a major component of the small measurement variation. No direct way of correcting this is immediately available but it appears that the degree of fractionation can be kept low by clean chemistry and careful mass spectrometry. A

series of measurements made on the Broken Hill Standard Galena, as oxalate, yielded isotopic abundances comparable to those obtained by modern gas source work, with a similar between-runs precision. (auth)

27149 ISOTOPIC ABUNDANCES OF LEAD FROM A FREQUENTLY-MIXED SOURCE. Russell, R. D.; Kanasewich, E. R.; Ozard, J. M. (Univ. of British Columbia, Vancouver). Earth Planet. Sci. Lett., 1: 85-8(Mar. 1966).

Isotope ratios were calculated for hypothetical leads as they would have developed in a succession of systems of random composition, each closed with respect to transfer of uranium, thorium and lead. The resulting ratios cannot be approximated by a single-stage model, but are reasonably well described by a two-stage anomalous lead model. This observation leads to important consequences in lead-abundance interpretations. In order to relate the study to an existing geological environment, the numerical values chosen were based on the anomalous leads from Broken Hill, Australia. The accepted interpretation for this suite of leads, which is well supported by independent argon-potassium and strontium-rubidium measurements, incorporates a two-stage model with the stages occupying the periods 4500 m.y. to 1600 m.y., and 1600 m.y. to 510 m.y. This model was simulated with a digital computer and compared with more complex models in which additional events were introduced between 1600 m.y. and 510 m.y. The greatest number of events considered was ten. In every stage but the first, the $^{238}U/^{204}Pb$ ratio for each sample was drawn at random from a lognormal distribution with mean value corresponding to 8.98 and 67% of the values lying between one-third and three times this value. In none of the cases did the calculated isotope ratios lie along primary isochrons, but they all did lie approximately along anomalous lead lines (secondary isochrons). Among other conclusions, this result implies that the assumption of frequent mixing of their source materials through sequential geologic processes is not sufficient to justify the interpretation of lead isotope ratios of individual samples on the basis of a single-stage model. (auth)

27150 FALLOUT OF ARTIFICIAL RADIOACTIVITY IN THE CARPATHIAN BASIN DURING 1964. Simon, Antal. Idojaras, 69: 168-73(May-June 1965).

Fallout data, collected at the observatories in Budapest, Debrecen, Pecs, Siofok, and Szeged with the aid of aerosol filter techniques, are presented and evaluated. Data on the radioactivity of the aerosol collected, on the yearly course (in 1964) of the radioactive sediment deposition, and the accumulated total sediment deposition for the year of 1964 are given. The variations between the findings at the different observatories are explained in terms of meteorological phenomena prevailing at the regions involved. (CFSTI)

27151 SEPARATION OF ^{210}Po FOR AN ACCURATE MEASUREMENT, BY ALPHA SPECTROMETRY, OF THE RATE OF ACCUMULATION OF POLAR SNOW. Nezami, Mehdi (CEN, Saclay, France). J. Chim. Phys., 63: 603-6(Apr. 1966). (In French).

A radiochemical method is proposed for measuring ages of polar ice at different levels and therefore obtaining data on the rate of accumulation of polar snow. The yield of ^{210}Pb was measured by the daughter ^{210}Po. Chemical separation, carried out before the counting of α rays, began with a coprecipitation of polonium sulfide with lead, and then Pb and Po hydroxides were precipitated. The polonium source was made by spontaneous electrodeposition on silver. The sensitivity was about 40 times larger with this method than with others. (auth)

27152 AIRBORNE RADIOACTIVITY IN ANTARCTICA. Lockhart, Luther B. Jr.; Patterson, Robert L. Jr.; Saunders, Allen W. Jr. (Naval Research Lab., Washington, D. C.). J. Geophys. Res., 71: 1985-91(Apr. 15, 1966).

The radioactive aerosol content of the surface air in Antarctica has been measured continuously since 1956, first at Little America station and later at the South Pole station. On-site measurements were made daily of the radioactivity due to bomb-produced fission products and to naturally occurring radionuclides of the radon and thoron series. Later, composite samples covering 3-month periods were subjected to radiochemical analysis for such long-lived radionuclides as ^{90}Sr, ^{137}Cs, ^{144}Ce, ^{147}Pm, and ^{210}Pb. The natural radioactivity was lower in Antarctica than has been observed at any other geographical location, as might be expected from the small area of exposed land surface in the vicinity. Fission-product concentrations, however, often exceeded those found in the southernmost part of South America and exhibited more well-defined seasonal variations, with maximums in the antarctic summer. (auth)

27153 THE VERTICAL DISTRIBUTION OF ^{137}Cs AND ^{90}Sr IN THE OCEANS. [PART] 2. Broecker, Wallace S.; (Columbia Univ., Palisades, N. Y.); Bonebakker, Erno R.; Rocco, Gregory G. J. Geophys. Res., 71: 1999-2003 (Apr. 15, 1966).

Further data are presented in support of previous conclusion that the vertical distributions of ^{137}Cs and ^{90}Sr are in accord with the ocean mixing rates demanded by the distribution of natural radiocarbon in the sea. As of early 1963 no significant activity appears to have penetrated below 500 meters in either the North Atlantic or equatorial Pacific oceans. A method for shipboard separation of Cs and Sr from 200-liter batches of seawater is outlined. (auth)

27154 DISTRIBUTION OF RADIOACTIVE MARINE SEDIMENT DERIVED FROM THE COLUMBIA RIVER. Gross, M. Grant (Univ. of Washington, Seattle). J. Geophys. Res., 71: 2017-21(Apr. 15, 1966).

Sediment from the continental shelf off Washington and Oregon contains radionuclides from the Hanford reactors. The distribution of radioactive sediment in 1963 indicated that particulate matter from the Columbia River is deposited near the river mouth and moves dominantly northward on the continental shelf. The distribution is apparently controlled by the variable wind and surface current regime near the Washington-Oregon coast. Radionuclides derived from atmospheric fallout were ubiquitous in the continental shelf sediments. (auth)

27155 RADIOSTRONTIUM FALLOUT FROM THE NUCLEAR EXPLOSION OF OCTOBER 16, 1964. Beck, J. N.; Kuroda, P. K. (Univ. of Arkansas, Fayetteville). J. Geophys. Res., 71: 2451-6(May 15, 1966).

The radiostrontium data obtained at Fayetteville, Arkansas, show that a considerable fraction of the debris from the October 16, 1964, nuclear explosion has entered the stratosphere. It is estimated that the stratospheric ^{90}Sr inventory has increased by 0.38% and the tropospheric ^{90}Sr inventory by 4.0% as a result of the Chinese nuclear explosion. The mean residence time of ^{90}Sr in the troposphere was calculated to be 30 days, according to the two-compartment model of the atmosphere. (auth)

27156 RADIONUCLIDES IN FOODS FROM THE CENTRAL PACIFIC, 1962. Palumbo, R. F.; Seymour, A. H.; Welander, A. D. (Univ. of Washington, Seattle). Nature, 209: 1190-2(Mar. 19, 1966).

During the 1962 series of atmospheric tests of nuclear devices near Christmas Island (Operation Dominic) a survey was conducted to determine the contribution of fallout radionuclides to radioactivity of foods in the central Pacific. Samples collected for the survey included foods from the area (2°N and 157°W), tuna fish from the seas within 960 km of the test site, and tuna fish caught by Japanese fishermen in an area that extended from 40°N to 25°S and from 140°W to 124°E. Results of analyses of food samples collected at Christmas Island and the outlying islands showed that small amounts of fallout radionuclides from Dominic were present in foods from some areas and in tuna from the area. Dominic fallout contributed very little to the radioactivity of tuna caught by the Japanese fishermen. Data are presented on the content of ^{140}Ba, ^{140}La, ^{57}Co, ^{60}Co, ^{137}Cs, ^{131}I, ^{103}Ru, ^{65}Zn, ^{95}Zr, ^{95}Nb, and ^{40}K in samples collected between March and Aug. 1962. (C.H.)

27157 OBSERVATIONS ON DEBRIS FROM THE FIRST CHINESE NUCLEAR TEST. Persson, G. (Research Inst. of National Defence, Stockholm). Nature, 209: 1228-9(Mar. 19, 1966).

The first Chinese nuclear device was exploded at 1500 hr on Oct. 16, 1964, at a test site near Lop Nor, a lake in the Takla Makan desert in Sinkiang. At this time the content of artificially produced radioactivity in the atmosphere was comparatively low because no fresh fission products from nuclear test explosions had been injected into the atmosphere since Dec. 1962. The short-lived nuclides from earlier tests had completely decayed. Traces of debris from the Chinese explosion were first detected in surface air in Sweden on October 27, 1964. Data are presented on average β activity of surface air and the mean values for some nuclides in samples from eight sampling stations and high-altitude samples from below and above the tropopause level collected during Oct. and Nov. 1964. Some fractionation factors were calculated in order to investigate fractionation phenomena in the debris. The data are reported and speculations on the source of the fissions are discussed. (C.H.)

27158 AIRBORNE OBSERVATIONS OF NATURAL RADIOACTIVITY. Behounek, F. (Faculty of the Technical and Nuclear Physics, Prague). Nature, 209: 1342-3(Mar. 19, 1966).

A discussion is presented on the measurements made by Warburton, Fookes, and Watt (Nature, 207: 181 (1965)) on radioactivity in the atmosphere up to 3.6 km. The day to day variations found to occur between the ground and the temperature inversion layers were determined as mainly radon and its decay products. These results are compared to the results of the direct determination of the radon content of free atmosphere at different altitudes made as early as 1928 by Wigand and Wenk (Ann. d. Phys. (4), 86, 657 (1928)). (B.G.D.)

27159 ESTIMATION OF ^{65}Zn BACKGROUND LEVELS FOR MARINE COASTAL WATERS. Alexander, G. V.; Rowland, R. H. (Univ. of California, Los Angeles). Nature, 210: 155-7(Apr. 9, 1966).

Data are presented on Zn and ^{65}Zn contents in tissues of marine animals collected along the Pacific coast near to and remote from the Columbia River. Specimens of barnacles, starfish, and mussels were collected during August of 1964. Tissues were dried by lyophilization and the radioisotope concentration was determined with a whole-body counter. To evaluate the background contamination level of ^{65}Zn on the Pacific coast, ^{54}Mn analyses were included to differentiate the contribution of fallout and ^{51}Cr was determined to evaluate the contribution from the Columbia River. It was concluded that coastal ^{65}Zn levels result essentially from fallout and that the present level in fallout is relatively constant at 0.05 to 2.7 pc ^{65}Zn/mg Zn. (H.G.D.)

27160 ^{90}Sr CONTENT OF FIRST BICUSPIDS. Rosenthal, Harold L.; Bird, John T.; Gilster, John E. (Washington Univ., St. Louis). Nature, 210: 210-12(Apr. 9, 1966).

Strontium-90 was determined in the crowns of first bicuspids in children born in the vicinity of St. Louis, Missouri between July 1, 1964 and May 1965. Results were related to dietary ^{90}Sr from fallout. The ^{90}Sr concentration in the crowns of permanent first bicuspids was plotted against the ^{90}Sr content of the diet, and the data were adequately described by a linear equation. The slope of the line equivalent to the discrimination factor between tooth crown and diet was calculated from the data to be 0.31. The usefulness of various types of teeth in indicating ^{90}Sr deposition at the time of tooth formation is discussed. (H.G.D.)

27161 MOVEMENT OF RADIOISOTOPES IN THE DRAIN SYSTEM. Saeki, Masamichi; Koyanagi, Taku (National Inst. Radiol. Scis., Chiba, Japan). Nuclear Eng. (Tokyo), 11: 55-8(Jan. 1965). (In Japanese).

Studies were made on the relation between the concentration of radioactive species in drainage and the fallout, the relation between the radioactivity in drainage and in the active mud, and the adsorption of radioactive species in the active mud. Of ^{95}Zr + ^{95}Nb, ^{103}Ru + ^{106}Ru, and ^{141}Ce + ^{144}Ce, intermediate half-life γ-active nuclides are observed as concentration changes in the drainage, which flows into the drain treatment area, several hours after they fell on the ground. These concentration changes are also observed at the same time in the active mud; they can be well retained in the active mud. For long half-life nuclides such as ^{90}Sr and ^{137}Cs, the amount of fallout and the concentration in the drainage cannot be related to each other by the short-period observation, but the relation between them may be observed by the long-period observation of the drain in the treatment area. There are many unknowns concerning the movement of radioactive species and also the adsorption of radioactive species in the active mud; therefore, no definite procedures for removing radioactive species from the drainage are yet established. Some radioactivity is found to still exist in the treated drainage. (NSA of Japan)

27162 ^{90}Sr FALLOUT FROM SURFACE AND UNDERGROUND NUCLEAR TESTS. Sotobayashi, Takeshi; Koyama, Seitaro (Niigata Univ., Japan). Science, 152: 1059-60(May 20, 1966).

The deposition of ^{90}Sr per unit area per unit fission energy from surface blast of the first Chinese atomic bomb was several times heavier than that from an earlier atmospheric test series. The venting of a Russian large-scale underground test also significantly increased deposition of ^{90}Sr at Niigata, Japan. (auth)

27163 DETERMINATION OF ^{144}Ce AND ^{137}Cs RADIONUCLIDES RATIO IN SOLID ATMOSPHERIC PRECIPITATIONS, IN BUCHAREST DURING THE WINTER 1963/1964. II. Voljin, N.; Ciudin, T. Studii Cercet. Fiz., 16: 1123-9(1964).

The collecting and analytical methods are described for samples taken between December 13, 1963 and February 19, 1964 in order to identify and determine the ratio of ^{144}Ce and ^{137}Cs radionuclides in the solid precipitations in Bucharest during that time interval. The spectrometer resolution was 11.5% for a 661 kev line of ^{137}Cs. The resulting spectrograms were analyzed in two ways: By deriving the radionuclide concentration ratio from the relation $n_{01}/n_{02} = E_{p2}n_{p1}/E_{p1}n_{p2}$, where E_{p1} and E_{p2} are the efficiencies corresponding to photopeaks in terms of the total efficiency of the crystal and of R, the ratio between the photopeak area and the total area of a monomagnetic radiation; and by assuming the occurrence of ^{95}Zr(^{95}Nb) and ^{106}Ru(^{106}Rh) radionuclides in the analyzed samples, the spectrogram of the samples taken from ^{95}Zr(^{95}Nb) and ^{106}Ru(^{106}Rh) standards was subtracted and the ^{144}Ce and ^{137}Cs radionuclides ratio was then similarly determined. A graphic representation of these results emphasized the higher values of this ratio and its more marked variations in the precipitation samples taken in Bucharest during the winter 1963/1964 as compared to those taken in previous winters; they must be considered as a natural outcome of the experimental nuclear tests carried out in the last few years. (Romanian Sci. Abstr.)

27164 TRITIUM IN SOUTHERN HEMISPHERE PRECIPITATION 1953–1964. Taylor, C. B. (Inst. of Nuclear Sciences, Lower Hutt, N. Z.). Tellus, 18: 105-31 (Feb. 1966).

THO deposition in the southern hemisphere is discussed in the light of currently available tritium measurements of southern hemisphere precipitation. Many new results are presented. Topics discussed include the seasonal and latitudinal variations of THO fallout, the fallout history of tropospheric and stratospheric thermonuclear THO, and the effects of the continental environment upon many of the reported measurements. (auth)

27165 TRACING RADIOACTIVE GRASSLAND CONTAMINATION IN THE AREA OF CSSR. Pinkas, J.; Pluhar, J. (Central State Veterinary Inst., Prague). Vet. Med. (Prague), 10: 705-10(Nov. 1965).

The radioactivity in grass due to fallout was investigated throughout Czechoslovakia, with special attention being

given to western and northern Bohemia. Higher values were found during the spring than in other periods of the year. Later on, during haymaking, substantially lower values were found. A spectrometric evaluation of the grass showed peaks of energies for ^{95}Zr, ^{95}Nb, ^{141}Ce, and ^{144}Ce. (CFSTI)

27166 RUBIDIUM–STRONTIUM MEASUREMENTS IN GLASSES OF BOSUMTWI-CRATER AND IVORY COAST TEKTITES. Lippolt, Hans J.; Wasserburg, Gerald J. (California Inst. of Tech., Pasadena). Z. Naturforsch., 21a: 226-31(Mar. 1966). (In German).

A Rb–Sr isotopic study of 5 glasses from the Bosumtwi crater in Ghana and of three Ivory Coast tektites was made. The $^{87}Sr/^{86}Sr$ ratios for the glasses lie between 0.716 and 0.734 and those for the tektites between 0.721 and 0.726. The ratios of Rb/Sr are between 0.196 and 0.328 for the crater glasses and between 0.197 and 0.287 for the tektites. The Ivory Coast tektites lie in a region of the Sr evolution diagram that is distinctly lower than for the other tektite groups. The Bosumtwi glasses define an approximately linear array on the Sr evolution diagram that contains the Ivory Coast tektite points. These results show that the IC tektites are distinctive from other tektite occurrences and suggest that the glasses and the tektites may represent fusion products of similar material. (auth)

27167 DETECTION OF ^{155}Eu IN RADIOACTIVE LONG-RANGE FALLOUT WITH THE HELP OF A Ge(Li) SEMICONDUCTOR DETECTOR. Kloes, H.; May, R.; Schneider, H. (Univ., Giessen, Ger.). Z. Naturforsch., 21a: 363-5 (Mar. 1966). (In German).

The γ spectrum of dust samples and rain water residues from the second half of 1963 was investigated with a Ge(Li) semiconductor counter. The radioisotopes ^{144}Ce, ^{137}Cs, ^{125}Sb, ^{106}Rh, ^{57}Co, and ^{54}Mn were found. The fission product ^{155}Eu was detected for the first time in the long-range fallout. (tr-auth)

27168 QUANTITATIVE RELATIONSHIPS BETWEEN GEOPHYSICAL PARAMETERS AND THE NATURAL ^{14}C INVENTORY. Houtermans, Jan (Univ. of California, San Diego, La Jolla). Z. Phys., 193: 1-12(1966).

The relations between observed variations of the specific radiocarbon activity in the atmosphere and possible secular variations in ^{14}C production rate, carbon residence times, and carbon reservoir size are calculated. As was shown previously, variations in these geophysical parameters which determine the natural ^{14}C activity in the atmosphere are strongly attenuated. Attenuation coefficients and phase shifts are calculated quantitatively and results are shown graphically. (auth)

27169 RADIOACTIVE FALLOUT IN PRAGUE IN 1964. Spurny, Kvetoslav; Machala, Oldrich (Inst. of Physical Chemistry, Prague). Zdrav. Tech. Vzduchotech., 8: 158-60(Aug. 1965).

In the first 2 months of 1964, the values were low, below $1 \cdot 10^{-8}$ C/m$^2 \cdot$ 28d. They were comparable to those registered in 1963. Between March and July, the values increased to $2.6 \cdot 10^{-8}$ C/m$^2 \cdot$ 28d; after that the values started to decrease, and reached the level below $1 \cdot 10^{-8}$ C/m$^2 \cdot$ 28d by the end of the year. The average value during the year was $1/4$ of that of 1963, and the maximum was only $1/5$ of the maximum in 1963. No correlation between fallout and the amount of rain was found, nor was there any correlation between atmospheric dust and fallout. The total fallout in Prague for 1964 was 137 mC/km^2. (CFSTI)

Techniques and Equipment

27170 (UCRL–14654-T) ELEMENTAL ANALYSIS USING NEUTRON INELASTIC SCATTERING. Waggoner, James A.; Knox, Richard J. (Lawrence Radiation Lab., Univ. of California, Livermore). [1965]. Contract W-7405-eng-48. 36p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

The technique of elemental analysis by analysis of the gamma rays resulting from the inelastic scattering of 14-Mev neutrons is described. This method is especially suitable for analysis of the major constituents of bulk samples such as planetary surfaces. Sample size, limits of sensitivity for Fe, Si, O, Mg, Al, Na, K, and Ca, detector resolution, shielding requirements, and geometrical effects are considered. An instrument designed for planetary surface analysis is described as one possible application of this method. This instrument weighs about 15 pounds and includes a pulsed source of 14-Mev neutrons, a gamma ray detector, and a 256 channel pulse height analyzer as well as the necessary electronics. (auth)

27171 ROUTINE ^{14}C DATING USING LIQUID SCINTILLATION TECHNIQUES. Tamers, M. A. (Instituto Venezolano de Investigacions Cientificas, Caracas). Acta Cient. Venezol., 16: 156-62(1965).

Developments in ^{14}C counting techniques for radiocarbon dating are reviewed, and some problems are discussed. In the use of liquid scintillation counting with benzene solutions, steady progress has been made. The development of new catalyst systems for the cyclization of acetylene to benzene with almost 100% yields has been accomplished. Counters with resolving times of less than 35 nsec in the coincidence unit have brought detection efficiencies up to the level of the internal sample gas counters. Employment of quartz face photomultipliers, special sample bottles, and bulk shielding have reduced the background. Based on experience accumulated in the determination of 400 dates in two laboratories, conclusions are made as to the feasibility of routine ^{14}C dating using liquid scintillation techniques. Radon contamination, isotope effect, and reproducibility of scintillation efficiency are discussed as well as counting methods and dating limits. The advantages of liquid scintillation counting for routine ^{14}C dating are enumerated. (BBB)

27172 SELECTIVITY OF THE YELLOWKNIFE SEISMIC ARRAY. Somers, H.; Manchee, E. B. (Dominion Observatory, Ottawa). Geophys. J., 10: 401-12(Jan. 1966).

An idealized signal, consisting of a noise-free, single-frequency infinite-duration input, is theoretically applied to the Yellowknife seismic array. A comparison of the output responses resulting from three possible signal processing techniques, viz. cross-correlation, sumall-squared, and multiple correlation, indicates that cross correlation is the preferred technique for determining the azimuth and velocity of arrival of the incident seismic energy. (auth)

27173 QUANTITATIVE INTERPRETATION OF GAMMA-RAY SPECTRAL LOGS. Rhodes, D. F.; Mott, W. E. (Gulf Research and Development Co., Pittsburgh). Geophysics, 31: 410-18(Apr. 1966).

From calculations of the intensity of unscattered gamma rays inside cylindrical self-absorbing sources, curves were developed that aid in the application of gamma-ray spectrometric techniques to borehole logging. Specifically, the curves provide factors which can be used to normalize spectral data to any standard set of borehole and formation conditions used for calibration. Taken into account are the effects of borehole diameter, mud density, casing and cement thickness, and detector eccentricity. Illustrative examples of applications of these curves depict the solutions to a variety of specific problems as well as methods for obtaining additional curves. Curves showing the portion of the log response due to gamma rays originating within specific zones of the formation provide an evaluation of the depth of investigation of the gamma-ray spectral log. (auth)

27174 THEORY AND METHOD FOR MATHEMATICAL SIMULATION OF γ-QUANTA SCATTERING. Dyad'kin, I. G.; Ponyatov, G. I. Izv. Akad. Nauk SSSR, Fiz. Zemli, No. 1, 47-58(1966). (In Russian).

An improvement to the Monte Carlo calculation for the simulation of radioactive prospecting of oil wells was reported. A substantial economy in the machine time was attained. (tr-auth)

27175 EXPERIMENTAL STUDIES OF NON-STATIONARY DIFFUSION OF THERMAL NEUTRONS IN A LAYER INTERSECTED BY A TIMBERED WELL. Sokolov, Yu. I. Izv. Akad. Nauk SSSR, Fiz. Zemli, No. 1, 100-6(1966). (In Russian).

The attenuation decrement was measured and the mean lifetime of thermal neutrons in the intrawell space was evaluated. The comparison of the experimental determination of τ_1 for timbered wells with τ_2 for mountain rock of productive strata of terrigenous and carbonate deposits of petroleum occurrences indicates that the case $\tau_2 > \tau_1$ occurs, i.e., the most favorable conditions for the measurement of the neutron parameters of the strata investigated. An analysis of the behavior of non-stable fields of thermal neutrons in wells with different constructions of the intrawell space made it possible to assume that the change of the diameter of the well and some possible displacement of the construction elements affects the size of the intensity of the long-lived exponents of the neutron drop. A change of the well diameter does not affect its attenuation decrement. The existence of dynamic behavior of the internal medium leads to the delay of the exponential drop in the density of thermal neutrons in the well. (tr-auth)

27176 SEISMIC SIGNALS FROM NUCLEAR EXPLOSIONS IN OVERDRIVEN CAVITIES. **Lewis, H. W. (Univ. of California, Santa Barbara); Treiman, S. B. J. Geophys. Res., 71: 2029-35(Apr. 15, 1966).**

A static treatment is given of the seismic signal from nuclear explosions in overdriven cavities, with particular attention to the role of the yield condition for the material of the cavity environment and to the role of incipient tension. When the elastic limits are exceeded, the seismic signal is larger than a purely elastic treatment would imply. This enhancement, however, grows relatively slowly with overdrive under certain circumstances. (auth)

27177 CONSTANTS OF RADIOACTIVE DECAY OF ^{40}K. **Rubinshtein, M. M.; Gel'man, O. Ya. Metod Opred. Absolyutnogo Vozrasta Geol. Obrazov., Akad. Nauk SSSR, No. 6, 32-9(1964). (In Russian).**

Various methods, including direct calculation and indirect geochemical measurements, and their variations used for determining the λ_K and λ_β constants of the radioactive decay of ^{40}K and for determining the absolute ages of rocks by the K–Ar method are reviewed. It is shown that the most recent determinations of λ_K and λ_β do not contradict each other. The values are $\lambda_K = 0.551 \times 10^{-10}$ and $\lambda_\beta = 4.72 \times 10^{-10}$ yr^{-1}. (M.C.G.)

27178 SEISMIC DATA ACQUISITION AND PROCESSING EQUIPMENT FOR EDINBURGH ROYAL OBSERVATORY. **Parks, R. (Royal Observatory, Edinburgh). Radio Electron. Eng., 31: 171-80(Mar. 1966).**

A description is given of two new seismic recording stations which have been established. One station, operated by the United Kingdom Atomic Energy Authority, produces continuous recordings on magnetic tape from a spaced array of short-period vertical seismometers and in a form suitable for subsequent processing by advanced techniques. The second station, operated by the Meteorological Office, produces conventional chart records from a set of seismometers covering three components of long period and three components of short period. A network of some 125 similar stations was set up around the world, using instruments with accurately matched characteristics so that comparisons can be drawn between records from different regions. The portable field recorders use frequency modulated recording on magnetic tape to handle the wide range of frequencies and amplitudes involved in seismic signals. Advantages and problems of mobile array stations are outlined, and the system design considerations for the recording equipment are discussed in detail, with a brief description of the units and their performance. The equipment and operation of the data lab are discussed, covering the following functions: playback of analog tapes, building of a library of events, preparation of data for computer input, playback of computer output, and simplified processing of data. (BBB)

27179 NEUTRON AND GAMMA RAY WELL LOGGING FOR CHLORINE CONTENT. **Owen, Joe D. (to Phillips Petroleum Co.). U. S. Patent 3,244,880. Apr. 5, 1966. Filed Dec. 27, 1960.**

A method and apparatus is provided for making a gamma ray log of downhole earth formations that is independent of the hydrogen log to more specifically differentiate between formations containing hydrocarbons and those containing salt water. A thermal neutron detector is added to a conventional chlorine logging tool having a gamma detector. The thermal neutron detector is positioned as close as possible to the gamma detector; and by the use of appropriate count rate meters and electrical analog circuitry, the output signal from the gamma ray detector is divided by the output signal from the thermal neutron detector for removal of the thermal neutron flux term from the output. A trace of this quotient produces a chlorine curve independent of the thermal neutron flux and, therefore, not dependent on the hydrogen content or porosity of the formations being logged. (B.L.M.)

Thorium and Uranium Minerals

Refer also to abstract 26779.

27180 GENESIS OF SPHEROIDAL AGGREGATES OF URANINITES. **Dymkov, Yu. M. At. Energ. (USSR), 20: 256-63(Mar. 1966). (In Russian).**

The characteristics of the crystalline growth of spheroidal aggregates of uraninite, which are seen as a pseudomorphic UO_{2+x} to U_3O_8, are briefly reviewed. It is shown that the hypothesis on the original precipitation of uraninite in the form of metastable U_3O_8 agrees with the representation of the conditions for the formation of aggregates from supersaturated solutions. (G.O.Y.)

27181 THE DETERMINATION OF URANIUM IN ROCKS AND MINERALS BY THE DELAYED NEUTRON METHOD. **Hamilton, E. I. (Dept. of Geology and Mineralogy, Oxford). Earth Planet. Sci. Lett., 1: 77-81(Mar. 1966).**

The uranium content of granite and acid rocks was determined for Skye, Scotland, southwest England, and in rocks of the Mid-Atlantic Ridge. The delayed neutron method was used, and the samples were ground to a grade of 400-mesh because of the heterogeneous uranium distribution. Results are given for various rock types and their locations. (J.F.P.)

HEALTH AND SAFETY

See also BIOLOGY AND MEDICINE — Radiation Hazards and Protection
GEOLOGY, METEOROLOGY, AND MINERALOGY — Natural Radioactivity and Fallout

Refer also to abstracts 26742 and 28852.

27182 (AD–627303) BASE LINE ENVIRONMENTAL RADIATION LEVELS INCLUDING MORATORIUM AND POST-MORATORIUM VALUES: ON THE FORT KNOX RESERVATION. Parr, Wordie H.; Lodde, Gordon M.; McPeak, Dailey W. (Army Medical Research Lab., Fort Knox, Ky. Biophysics Div.). Sept. 27, 1965. 34p. (AMRL–635). CFSTI $2.00 cy, $0.50 mn.

An environmental radioactivity study was conducted for the first time on the Fort Knox Reservation for the purpose of establishing base line radiation levels. Comparisons of radiation levels during and after the nuclear moratorium (Jan. 1960 to Jan. 1963) are reported. Air samples were collected in the laboratory area during the normal work week, whereas water, silt, and soil samples were routinely collected at monthly intervals from strategic locations. Description of sampling procedures and radioactivity measuring techniques are included. Activity measurements on the Reservation show that radiation levels are influenced by world-wide nuclear detonations. Low and relatively steady levels are correlated with the moratorium, while fluctuating but increasing values accompanied the resumption of the nuclear testing programs. (STAR)

27183 (AD–627332) A MATHEMATICAL MODEL OF FLASHBLINDNESS. Final Report, November 1, 1964–August 31, 1965. Czeh, S.; Casper, Arthur W.; Segraves, Ernest C. Jr. (General Electric Co., Oklahoma City, Okla.). Oct. 1965. Contract AF41(609)-2644. 68p. CFSTI $3.00 cy, $0.75 mn.

In planning certain military missions it is desirable to know the extent to which vision may be impaired by the flashblindness that can result from the intense light of a nuclear explosion. This report describes an attempt to provide assistance to such planning by constructing a mathematical model of flashblindness. The literature was surveyed to determine whether or not the construction of a model was feasible. Using selected data, two equations were developed for predicting recovery time from flash energy, display luminance, and display visual acuity. The prediction errors made were determined in a few situations and compared with the errors made by other prediction techniques. Limitations of the applicability of the equations were noted. (STAR)

27184 (AD–632865) ENVIRONMENTAL HEALTH PLANNING FOR POSTATTACK CONDITIONS: SOME PROBLEMS, PROGRAMS, AND PRIORITIES. Final Report. Salmon, Raphael J. (Research Triangle Inst., Durham, N. C. Operations Research and Economics Div.). Apr. 1966. Contract PH-86-65-16. 77p. (R-OU–197). CFSTI $3.00 cy, $0.75 mn.

A framework to help decision-makers evaluate postattack conditions relative to environmental health was developed. Review and analysis of existing information on probable postattack conditions as they might affect, and be affected by, personnel of local health departments, public health organizations, and resource management practices is presented. Anticipated postattack environmental health problems are identified, and priority judgments are made on a comparative basis in terms of level of gravity. Rationale supporting the judgments is included, and both action and research programs to improve preparedness are recommended. Four city health departments were visited to assist in analysis of normal environmental health conditions relative to those expected in a postattack recovery period and of the ability of a local health agency to cope with projected conditions. (P.C.H.)

27185 (AD–632989) DECONTAMINATION OF LAND TARGETS, VEHICLES, AND EQUIPMENT. Maloney, J. C.; Meredith, J. L. (Army Nuclear Defense Lab., Edgewood Arsenal, Md.). May 1966. 70p. (NDL-TR–66). CFSTI $3.00 cy, $0.75 mn.

Decontamination experiments on exterior surfaces made radioactive with small-particle simulant, and decontamination studies on railroad tracks, transportation vehicles, and mechanical equipment used for radiological recovery operations are described. Approximately 150 decontamination trials were conducted at Camp McCoy, Wisconsin, during 1964 and 1965. Standard reclamation techniques when applied to 20- to 75-μ fallout on land targets were found to be less effective than when applied to larger particle ranges. The reclamation techniques of air and water hosing were of limited effectiveness when applied to railroad track areas. The passage of fast trains can be expected to effectively remove fallout from the track area under the train. Vehicles and equipment contaminated with fallout are effectively decontaminated by dry manual and airhosing procedures, and in some cases, by weathering effects. First-echelon effort with a broom was adequate and reasonable. The presence or use of water, especially in below-freezing weather, can adversely affect the decontamination of vehicles and equipment. (auth)

27186 (AHSB(RP)-R–58) A REVIEW OF THE TOXICOLOGY AND POTENTIAL HAZARDS OF NATURAL, DEPLETED AND ENRICHED URANIUM. Bennellick, E. J. (Authority Health and Safety Branch, United Kingdom Atomic Energy Authority, Harwell (England)). Mar. 1966. 44p. Dep. BIS $1.20, HMSO 6s.

Data are summarized from a selection of published and unpublished data on uranium, its compounds and alloys. The main physical, chemical, and nuclear properties and biological behavior of uranium are reviewed from the standpoint of potential hazards. The toxicology of uranium is discussed and the derived working limits for exposure to the material formulated by the United Kingdom Atomic Energy Authority are presented. Data are included on external radiation dose rates including those from processed irradiated uranium. Fire and explosion hazards and criticality aspects of uranium are discussed. (110 references.) (C.H.)

27187 (BLG–365(Vol.2)) DIFFUSION DES REJETS ATMOSPHERIQUES DANS LA REGION DE MOL. (Diffusion of Atmospheric Effluents in the Vicinity of Mol). Bultynck, H.; de Maere, X.; van der Parren, J.; Malet, L. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). Dec. 1965. 78p. Dep. mn.

Graphs for the calculation of the diffusion of atmospheric effluents are presented. (J.S.R.)

27188 (BNWL-SA–22) MEASURED AND CALCULATED SURFACE DOSE RATES OF PLUTONIUM AND PLUTONIUM OXIDES. Faust, L. G. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 7, 1965. Contract AT(45-1)-1830. 19p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

An extrapolation chamber was used to measure the x-ray and gamma surface dose rates of metallic plutonium, PuO_2, and PuO_2-UO_2 mixtures. Data are presented showing the changes in the surface dose rates of metallic plutonium with changes in the plutonium isotopic composition. The surface dose rate of plutonium metal was compared to the dose rate after the metal was oxidized. Surface dose rate values are presented for different weight per cents of PuO_2 in PuO_2-UO_2 mixtures. Measured values for the dif-

ferent materials are summarized. Measured and calculated surface dose rates for plutonium metal were found to be in excellent agreement; they are 1.69 and 1.62 rad/hr, respectively. An equation to calculate the surface dose rate of plutonium due to neutrons is presented but no direct comparisons between the equation and measured surface dose rate values were made. Attenuation factors are presented for plastic transfer bagging material and hood gloves currently in use at Pacific Northwest Laboratory. (auth)

27189 (BNWL-SA-26) A NEW TECHNIQUE FOR PLUTONIUM PARTICLE SIZE ANALYSIS. Andersen, B. V. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 7, 1965. Contract AT(45-1)-1830. 14p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

A procedure to determine plutonium particle sizes based on the concept of fission fragment damage to plastics, glasses, and natural crystals is described. The availability of a high thermal neutron flux and the good thermal fission cross-section of plutonium isotopes contribute to make the fission fragment damage phenomena a sensitive analytical tool for plutonium. Integrated neutron flux of from 10^{13} to 10^{17} nvt are employed to create damage sites in three-mil plastic film at locations covered by plutonium particles. Holes are etched in the plastic in the damaged locations by treatment in a warm caustic solution. Particle sizes in the submicron range are easily measured. Particle size distributions obtained by the autoradiographic alpha track film and by the fission fragment damage phenomena are illustrated and discussed. (P.C.H.)

27190 (BNWL-SA-155) SNOW AND RAIN WASHOUT COEFFICIENTS FOR INORGANIC IODINE VAPOR. Engelmann, R. J.; Perkins, R. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 16, 1965. Contract AT(45-1)-1830. 5p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Washout coefficients for gaseous iodine in snowfall and an estimate of the coefficient for rainfall were experimentally determined for the first time. The coefficient for rain is in agreement with theory. The coefficient for snow appears to depend upon crystal type and size as well as upon snowfall rate. (auth)

27191 (BNWL-SA-212) A SYSTEM FOR CONTINUOUS MONITORING OF DOSE RATE TO THE G.I. TRACT FROM DRINKING WATER. Bramson, P. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 7, 1965. Contract AT(45-1)-1830. 11p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Drinking water supplies may be continuously monitored for G. I. tract dose due to radionuclides in water by appropriately designed radiation detection equipment. The equipment consists of a hollow cylindrical plastic scintillator coupled to a photomultiplier tube, pulse height discriminator, solid state amplifier, and counter. A 0.5 liter per minute continuous sample of the drinking water is circulated through the scintillator cavity. The count rate output is proportional to the G. I. tract dose rate for ^{76}As, ^{51}Cr, ^{64}Cu, ^{24}Na, ^{239}Np, ^{32}P, ^{46}Sc, and ^{65}Zn. This proportionality is achieved by a properly chosen scintillator shape, scintillator surface-to-volume ratio, and pulse height discrimination level. Ninety per cent of the G. I. tract dose rate from the consumption of drinking water derived from the Columbia River at Richland, Washington results from the decay of these radionuclides. Detection of 1 ± 1 mRem per month, G. I. tract dose, is possible within broad limits of relative concentration for the above-listed radionuclides. Contamination buildup within the scintillator is effectively controlled by a continuous metered injection of NaEDTA solution to the water flowing through the scintillator cavity. The system has operated full time since October 1964. (auth)

27192 (BNWL-SA-671) TRANSPORT ANALYSIS: BASIC PREDICTIVE APPROACH OF THE MOVEMENT OF POLLUTANTS THROUGH SOIL. Cearlock, D. B. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 3, 1966. Contract AT(45-1)-1830. 18p. (CONF-660523-2). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From 21st Annual Purdue Industrial Waste Conference, Lafayette, Ind.

Transport analysis for determining distribution of pollutants through soil is discussed. Since the transport equation describes two independent phenomena, fluid movement and pollutant reactions (the reactions of the pollutant with its environment), the analysis was simplified by investigating them separately. The transport equation was then used to combine these into one interrelated equation which yields the concentration distribution of the pollutants involved. (P.C.H.)

27193 (BNWL-SA-678) PREDICTION OF WATER MOVEMENT THROUGH SOILS—A FIRST STEP IN WASTE TRANSPORT ANALYSIS. Nelson, R. William; Eliason, Jay R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 20, 1966. Contract AT(45-1)-1830. 22p. (CONF-660523-1). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From 21st Annual Purdue Industrial Waste Conference, Lafayette, Ind.

Recent theoretical advances made in studies on the flow of fluids in porous media are interrelated to problems involving the transport of pollutants through soils. Three broad phases of analysis are involved in predicting contaminant transport through porous media. They are: the macroscopic fluid flow analysis; the microscopic flow analysis for diffusion and hydrodynamic dispersion, and the reactions or interactions of contaminants with the porous material, organic material or biological components of the soil. Macroscopic flow analysis was determined and used to predict river contaminant concentration. (P.C.H.)

27194 (CONF-660405-14) CONCENTRATION OF ^{137}Cs AND ^{55}Fe THROUGH FOOD CHAINS IN ARCTIC AND SUBARCTIC REGIONS. Miettinen, J. K. (Helsinki Univ. (Finland). Dept. of Radiochemistry). [1966]. Contract AT(30-1)-3446. 11p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From Symposium on Radioecological Concentration Processes, Stockholm.

Lichen grows in large quantities in Arctic regions and exhibits extremely slow growth habits and an enormous capacity to absorb nutrients from the air and rain water. During the long winter season caribou and reindeer subsist almost entirely on lichens, and the Eskimos consume enormous quantities of meat from these animals. Fallout nuclides absorbed by lichens are transported by the food chain to man. The movement of ^{137}Cs and ^{90}Sr within lichens are described and the transport of ^{137}Cs and ^{55}Fe through the food chain to man is discussed. It is pointed out that ^{90}Sr is deposited in the bones of reindeer, which are not eaten by man. Iron-55 is concentrated in marine fish in Arctic waters and Eskimos who consume large amounts of fish have body burdens of radioactivity higher than that of caribou eating natives. Data are presented on the content of ^{137}Cs, ^{55}Fe, and other fallout fission products in natives and foods of Alaska, Finland, and Sweden in 1965. Seasonal variations are discussed. (C.H.)

27195 (DPST-66-30-1) EFFECT OF THE SAVANNAH RIVER PLANT ON ENVIRONMENTAL RADIOACTIVITY. Semiannual Report, July–December 1965. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Plant). Contract AT(07-2)-1. 16p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

The results of an environmental monitoring program for the atmosphere, vegetation and food, and water for the period July 1 through Dec. 31, 1965 are reported. The quantity of radioactive waste released by the Savannah River Plant to its environs was, for the most part, too small to be distinguished from natural background radiation or was obscured by worldwide fallout from nuclear weapons testing during past years. Beta activity in air, which showed no relationship with plant operations, was about one-fifth that for the same period of 1964. Radioactive materials in fish flesh continued to be far below levels considered significant from a health standpoint. The average concentration of radioisotopes in river water did not

exceed 4.1% of the Maximum Permissible Concentrations. (auth)

27196 (HASL–170) FURTHER STUDIES OF EXTERNAL ENVIRONMENTAL RADIATION. Beck, H. L.; Lowder, W. M.; Bennett, B. G.; Condon, W. J. (Health and Safety Lab., New York Operations Office (AEC), N. Y.). Mar. 1966. 53p. Dep. mn. CFSTI $3.00 cy, $0.50 mn.

Spectrometric techniques developed for measuring total and individual component gamma dose rates from naturally occurring and fallout emitters are elaborated upon and extended to new applications. The calibration of high resolution 4 × 4 in. NaI(Tl) detectors for such measurements is described. Field studies utilizing these techniques during 1965, including measurements of gamma dose rates at approximately 50 ground sites scattered around the United States as well as on high altitude lakes and in deep mines, are summarized and the data presented in full. These results provide useful information relevant to continuing studies of the application of field spectrometry to the rapid assessment of fallout deposition, particularly ^{137}Cs, the variations of natural gamma dose rate with time, and the contributions of soil beta activity and cosmic radiation to free air ionization near the air-ground interface. A detailed description of the argon-filled high pressure ionization chamber used for total dose rate measurements is presented. (auth)

27197 (HASL–175) THE CONTRIBUTION OF URANIUM SURFACE CONTAMINATION TO INHALATION EXPOSURES. Breslin, A. J.; George, A. C.; LeClare, P. C. (Health and Safety Lab., New York Operations Office (AEC), N. Y.); Glauberman, H. (New York Operations Office (AEC), N. Y.). May 1966. 20p. (CONF-660403–3). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From International Symposium on Radiological Protection of the Worker by the Design and Control of his Environment, Bournemouth, Eng.

The actual inhalation exposures of employees from contamination originating on surfaces in a uranium plant were measured. Validity of the technique was demonstrated previously. Surface contamination was found to contribute a very small proportion of the total inhalation exposures even in areas where levels of surface contamination were relatively high with respect to suggested standards. (P.C.H.)

27198 (JAERI–1101) GRAPHIC AID TO OBTAIN CONCENTRATION OF MATERIALS RELEASED FROM NUCLEAR PLANT TO THE ENVIRONMENT (BASED ON THE ENGLISH METHOD). Kakuta, Michio; Iijima, Toshinori (Japan Atomic Energy Research Inst., Tokyo). Oct. 1965. 72p. (In Japanese). Dep. mn.

Of the various methods for estimating the concentration of materials released from the point source to the atmosphere, the so-called English Method is widely used in hazard evaluation in Japan. This method is based on the assumption that both the lateral and vertical concentration distributions due to the atmospheric turbulence are Gaussian. The concentration distributions are calculated on the basis of the English Method and are summarized in graphs for practical use. To help in the environmental radiation monitoring practice and the hazard evaluation procedure, special attention was given to the expression of figures and the selection of parameters. (auth)

27199 (JAERI–4036) PLUTONIUM HANDLING TECHNIQUES ESPECIALLY IN FRENCH LABORATORIES. Tsujino, Takeshi (Japan Atomic Energy Research Inst., Tokyo) Oct. 1965. 42p. (In Japanese). Dep. mn.

Based on experiences in plutonium handling in France, the plutonium handling techniques in chemical laboratories are summarized. Laboratory facilities, equipment, regulations, and techniques for handling plutonium are discussed. The chemical and physical properties of plutonium and the safety problems are also outlined. Abstracts of 37 papers on plutonium handling are appended. (auth)

27200 (K–1663) HYDROGEN MODERATION—A PRIMARY NUCLEAR SAFETY CONTROL FOR HANDLING AND TRANSPORTING LOW-ENRICHMENT UF_6. Newlon, C. E.; Mallett, A. J. (Oak Ridge Gaseous Diffusion Plant, Tenn.). May 31, 1966. Contract W-7405-eng-26. 20p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

The use of hydrogen moderation as a primary nuclear safety control has been in effect for many years for large-scale UF_6 shipments among AEC-owned contractor-operated facilities. Since it appears that the extension of the use of moderation-controlled shipments to licensee as well as contractor organizations is desirable, research done in developing basic criticality data and the necessary equipment and operational techniques are summarized. (auth)

27201 (LA-DC–7590) DECONTAMINATION EXPERIENCE IN THE DESIGN AND OPERATION OF THE PLUTONIUM PROCESSING FACILITIES AT LOS ALAMOS. Christensen, E. L.; McNeese, W. D.; Maraman, W. J. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Apr. 1966. Contract W-7405-eng-36. 36p. (CONF-660520–2). Dep. mn. CFSTI $2.00 cy, $0.50 mn.

From International Symposium on the Decontamination of Nuclear Installations, Harwell, Eng.

Improvements in drybox design, ventilation control, equipment arrangement with emphasis on secondary containment for high risk areas or operations, decontamination procedures, operator training, construction materials, and operating philosophy as they pertain to the Los Alamos Scientific Laboratory's plutonium processing facility are discussed. (P.C.H.)

27202 (NP–16041) DATA FROM RADIATION PROTECTION PROGRAMS. Volume 4, Number 3. (Department of National Health and Welfare, Ottawa (Ontario). Radiation Protection Div.). Mar. 1966. 26p. Dep. mn.

Two articles are included on Canadian fallout for Feb. 1966 and reactor environment monitoring for Feb. 1966. Separate abstracts were prepared for each. A selected list of divisional reports and bulletins is also included. (P.C.H.)

For abstracts of individual papers see: 27203 and 27204

27203 (NP–16041, pp 3-13) CANADIAN FALLOUT DATA FOR FEBRUARY 1966. Samuels, E. R.; Mohindra, V. K. (Department of National Health and Welfare, Ottawa (Ontario). Radiation Protection Div.).

The results of analyses carried out on samples of air, precipitation, and milk collected in Feb. 1966 are reported. Total beta activity was determined in air and precipitation, ^{90}Sr and ^{137}Cs in precipitation, and ^{90}Sr in milk. Fallout levels during Feb. 1966 generally remained unchanged from those observed during the previous month. Total beta activity in air and precipitation samples remained at very low levels. The average concentrations of ^{137}Cs and ^{90}Sr in liquid milk were 60 and 21 pC/l, respectively. (P.C.H.)

27204 (NP–16041, pp 14-24) REACTOR ENVIRONMENT MONITORING FOR FEBRUARY 1966. Samuels, E. R.; Mohindra, V. K. (Department of National Health and Welfare, Ottawa (Ontario). Radiation Protection Div.).

Total alpha activity, total beta activity, ^{90}Sr, and ^{137}Cs determinations were made on water and milk samples in the environment of Canadian reactors. The results did not show any anomalies that could be attributed to a release of contamination from the reactors. (P.C.H.)

27205 (NRL–6374) THE EXTENT OF RADIOACTIVE EQUILIBRIUM BETWEEN RADON AND ITS SHORT-LIVED DAUGHTER PRODUCTS IN THE ATMOSPHERE. Lockhart, L. B. Jr.; Patterson, R. L. Jr. (Naval Research Lab., Washington, D. C.). Nov. 9, 1965. Contract AT(49-7)-2435. 19p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

A set of experimental conditions was derived that optimizes the accuracy with which the radon content of the atmosphere and its apparent residence time there can be determined from measurement of the filterable gross β activity during two separate 10-min. periods following the

end of a 20-min. collection period. The 20-min. collection is made on a filter of essentially 100% retentivity (glass fiber filter) and counted for β activity through a 10-mil (70 mg/cm^2) aluminum absorber on equipment of known efficiency for the β particles emitted by RaB and RaC. The ratio of measured counts during the 61-through-71-min. decay period to that during the 1-through-11-min. period is used to obtain the atom ratio of RaC to RaB(ρ) in the air sampled, the apparent age (τ) of the conglomerate of radon and its daughters, and the total counts to be expected from any given radon concentration in the air. Extensive examples of atmospheric measurements are given which suggest that under most conditions in the free atmosphere radon is essentially at secular equilibrium with its daughter products. Other collections made following addition of radon to a restricted volume showed the expected increase in ρ with time, which confirmed the basic validity of the procedure. (auth)

27206 (NYO–3446-5) THE SECOND ANNUAL PROGRESS REPORT [ON PROJECT LAPLAND, 1965]. Miettinen, Jorma K. (Helsinki Univ. (Finland). Dept. of Radiochemistry). May 12, 1966. Contract AT(30-1)-3446. 3p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Results of whole-body counting of Finnish Lapps during March and April, 1966, showed a 15% decrease in radioactivity over April, 1965. Lichen and reindeer meat also showed a similar decrease. Data are included on the content of ^{137}Cs, ^{55}Fe, and ^{90}Sr in blood and urine samples from a Lapp population with extremely low Ca intake and another population whose diet contains a great deal of Arctic Ocean fish. Food chains of ^{55}Fe were studied in Lapland waters and on the dry land, and the chain lichen-reindeer-man was studied on 3 trophic levels, and dietary studies of ^{137}Cs and ^{90}Sr were made on Lapps and Southern Finns. A list is included of 6 papers published during the period covered by this report. (C.H.)

27207 (ORNL-NSIC–16) INDEXED BIBLIOGRAPHY OF CURRENT NUCLEAR SAFETY LITERATURE–5. (Oak Ridge National Lab., Tenn.). June 1966. Contract W-7405-eng-26. 214p. Dep. mn. CFSTI $6.00 cy, $1.25 mn.

Approximately 900 references are given to reports, journals, and books published through Jan. 1966. Nineteen categories are included for information relevant to the analysis and control of hazards associated with nuclear reactors, operations involving fissionable materials, and the products of nuclear fission. Primary emphasis is on safety in reactor design, construction, and operation; however safety considerations in reactor fuel fabrication, spent-fuel processing, nuclear waste disposal, and related operations are also included. (P.C.H.)

27208 (ORNL-TM–1478) RELEASE OF TRITIUM FROM TRITIUM-LABELED LUMINOUS PAINTS. Handley, Thomas H. (Oak Ridge National Lab., Tenn.). June 1966. Contract W-7405-eng-26. 11p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Samples of commercially supplied tritiated organic polymers used in luminous paints were tested for release of tritium. During the drying period following application, tritium release decreased only slightly with time. Loss of tritium by the dried paint was roughly exponential with respect to temperature for certain paints and for others a stepwise change was noted. The tritium was released chiefly as tritiated water. (auth)

27209 (RM–4910-TAB) A RE-EXAMINATION OF FALLOUT MODELS. Rapp, R. R. (RAND Corp., Santa Monica, Calif.). Feb. 1966. Contract AT(04-3)-414. 52p. Dep. mn. CFSTI $3.00 cy, $0.50 mn.

The steps necessary to produce an operational fallout model are reviewed. Each facet of the problem is discussed, the attendant difficulties pointed out, and the possible compromises suggested. A comparison of recent fallout models was attempted so that the strengths and weaknesses of each can be assessed. Finally, a suggested program for the development of a flexible computer model is made. Such a model could provide a means for examining the variation in prediction as a function of the variation in the input. (auth)

27210 (UCRL–14680) HAZARDS CONTROL QUARTERLY REPORT NO. 23, OCTOBER–DECEMBER 1965 AND INDEX TO HAZARDS CONTROL QUARTERLY REPORTS, NOS. 20 THROUGH 23. (Lawrence Radiation Lab., Univ. of California, Livermore). Contract W-7405-eng-48. 46p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

Results of studies on: attenuation and absorption coefficients for ^{6}LiH, ^{6}LiD, ^{7}LiH, and BeO; radioactive gas production at a 100 Mev electron Linas facility; airborne radon/radon-daughter secular equilibrium measurements using alpha pulse spectroscopy; and testing off-gas air cleaning systems for efficiency in removing methyl iodide are reported. Designs are given for improved shipping container for fissile material, a mobile radiological laboratory, and concrete waste blocks. Subject and author indexes for Hazards Control Quarterly Reports Nos. 20 through 23 are included. (P.C.H.)

27211 (USNRDL-TR–991) RADIOCHEMICAL DATA CORRELATIONS FOR SEAWATER AND CORAL-SURFACE BURSTS. Crocker, G. R. (Naval Radiological Defense Lab., San Francisco, Calif.). Jan. 22, 1966. Contract AT(49-7)-1963. 32p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

Radiochemical data on fallout samples from three high-yield surface bursts were correlated by a method of log-log plotting. The correlations were comparable with those available for similar burst conditions. The results confirmed the utility of the method and indicated the strong effects of fractionation on the radiochemical composition of fallout from surface bursts. (auth)

27212 INTERPRETATION OF AIR SAMPLING FOR RADIOACTIVE PARTICLES. Sherwood, R. J. (Atomic Energy Research Establishment, Harwell, Eng.). Amer. Ind. Hyg. Ass. J., 27: 98-109(Mar.-Apr. 1966). (AERE-R–4491).

Results are reported from a five-year program of studies of air samples taken in operational areas where radioactive substances are handled. The special instruments and techniques developed for this purpose are briefly described. For the areas studied, the results indicate that routine air sampling for radioactive particles may not give a reliable indication of human exposure and that more attention should be given to the interpretation of air sampling results. (auth)

27213 METHOD FOR DETERMINING RELATIVE AMOUNTS OF COMBINED AND UNCOMBINED RADON DAUGHTER ACTIVITY IN UNDERGROUND URANIUM MINES. Craft, Bob F.; Oser, James L.; Norris, F. Warren (Public Health Service, Salt Lake City, Utah). Amer. Ind. Hyg. Ass. J., 27: 154-9(Mar.-Apr. 1966).

A method for determining relative amounts of uncombined radon daughter decay products has been developed. Because of the different diffusion coefficients of atomic-size radon daughter products compared with those combined with particulates, a diffusion tube will separate out a calculable fraction of the atomic-size daughter products and permit larger particulates to pass through the tube. Data obtained from samples collected at several active underground working faces in uranium mines indicate substantial amounts of highly mobile radon daughter alpha activity. (auth)

27214 AROMATIC HYDROCARBONS IN NUCLEAR SUBMARINE ATMOSPHERES. Chiantella, A. J.; Smith, W. D.; Umstead, M. E.; Johnson, J. E. (Naval Research Lab., Washington, D. C.). Amer. Ind. Hyg. Ass. J., 27: 186-92(Mar.-Apr. 1966).

An analytical study was directed to the identification and determination of individual aromatic hydrocarbons present in nuclear submarine atmospheres in concentrations of parts per million or less. Hydrocarbon oil samples were desorbed from activated carbon which had been exposed in submarine atmospheres. The aromatic hydrocarbon content of these oils was approximately 25 to 30% of the total. The quantitative distributions of individual aromatic hydrocarbons found in submarines were strikingly similar to those of typical petroleum distillates in the same boiling range. Several commerical petroleum prod-

ucts were studied as possible sources of hydrocarbons in submarine atmospheres. (auth)

27215 THE INFLUENCE OF THERMAL STRATIFICATION AND PLANKTON ORGANISMS ON THE DISTRIBUTION OF FALL-OUT RADIOACTIVITY IN A WATER RESERVOIR. Bernhardt, H.; Haberer, K. (Technische Hochschule, Karlsruhe, Ger.). Atompraxis, 12: 142-7 (Mar. 1966). (In German).

The extensive precipitation of radioactivity during the spring and summer of 1963 made it possible to study the distribution of fission-product activity in a drinking-water reservoir by measuring β and γ activities. Limnological and planktological conditions were taken into account in evaluating the results. It was found that during the summer of 1963 the fission nuclides that entered the reservoir via precipitation or inflow were collected mainly in the epilimnion, and did not increase the radioactivity present in the hypolimnion before the development of stratification. Actually there was a decrease in activity, owing to subsidence. The partial circulations, which began in autumn, gradually led to a completely uniform distribution of radionuclides in all depths, owing to the continuous mixture of epilimnetic water with parts of the hypolimnetic water. The distribution of radioactivity in such a reservoir thus runs parallel to the temperature distribution. The nature of the gradual shift in the activity relationship between γ and β emitters led to the conjecture that the strontium isotopes remain in the free-water zone to a greater extent than do undissolved or colloidal radioactive substances, which undergo a certain sedimentation. (auth)

27216 SHIPMENT OF IRRADIATED FUEL FROM THE LATINA PLANT. Sani, Luciano. Comit. Naz. Energ. Nucl., Notiz., 12: No. 4, 48-57(Apr. 1966). (In Italian).

The various stages in the shipment of irradiated fuel from the Latina Plant are reviewed. This operation involves the solution of several technical and organizational problems, which have to be dealt with on an international scale, not on a one-lot basis but in view of a series of shipments repeated over a considerable number of years. (auth)

27217 TRANSPORT OF NON-IRRADIATED FISSILE MATERIAL UNDER THE INTERNATIONAL ATOMIC ENERGY AGENCY REVISED TRANSPORT REGULATIONS. Marriott, A. J.; Howden, J. L. (Atomic Weapons Research Establishment, Aldermaston, Eng.). J. Brit. Nucl. Energy Soc., 5: 137-45(Apr. 1966).

The purpose of this paper is chiefly to recount those parts of the IAEA's regulations which deal with the transport of non-irradiated fissile materials and to review UKAEA Atomic Weapons Research Establishment's (AWRE) experience, with related recommendations on design, manufacture, and maintenance of packings. The paper does not deal with the details of calculations appertaining to criticality clearance certification. (auth)

27218 CIVIL DEFENSE FOR AUSTRALIAN CITIES. Liddle, William (Royal Australian Air Force Volunteer Reserve, Brisbane). Med. J. Austral., 2: 502-7(Sept. 18, 1965).

Medical aspects of the response to an attack on Australia with thermonuclear weapons are considered. The putative targets for atomic attack in Australia, the mainland capitals, differ from European and Asiatic cities because they are sturdy; not overcrowded; and surrounded to a depth of many miles by satellite towns, dormitory suburbs, and pockets of habitation. The aggregate population of these surrounding areas is a significant fraction of the metropolitan population, so that an atomic detonation above an Australian city would leave retrievable casualties and uninjured rescuers in ~equal numbers. The fact that the injured would be counted in scores of thousands renders this problem unique. The normal medical facilities of the city, the major hospitals, and the large ambulance stations would be destroyed. Citizens of the surrounding safe areas would need to enter the devasted zone and physically remove the injured. The survivors would be suffering from one or more of the following conditions: flash burns; flame burns; injuries from secondary missiles, such as flying glass; and the effects of ionizing radiation. Treatment of these injuries is discussed, and an assessment made of medical supplies and equipment needed to care for large numbers of casualties. The major burden in the second stage of management of injuries would fall upon the doctors and trained nurses dwelling in the safe areas. Doctors would probably be working in the ratio of one to 1000 patients. Training of medical and paramedical personnel to handle casualties of a thermonuclear attack is proposed and specific recommendations made. (BBB)

27219 INTERNATIONAL COOPERATION IN RADIONUCLIDE MEASUREMENT AT THE B.I.P.M. Terrien, J. (Bureau International des Poids et Mesures, Sevres, France). Metrologia, 2: 57(Jan. 1966).

The urgent need for accuracy and world-wide uniformity in the measurement of ionizing radiations, which gave rise to the creation of a new section at the Bureau International des Poids et Mesures (BIPM) has been met successfully in the field of standardizing radionuclides, as was noted at the meeting of a Working Group in the BIPM lab (September 1965). International agreement among the most advanced standardizing laboratories in the absolute determination of activity standards, in terms of number of disintegrations per sec, is now getting out of the one or two % range; precisions of the order of one part/1000 appear possible in such important cases as thin solid sources of ^{60}Co, the decay scheme of which is simple and well known. The results of recent international comparative measurements of the sp act. of solutions of ^{54}Mn, ^{60}Co, $^{90}Sr + {}^{90}Y$, and ^{241}Am were also discussed at the meeting, and agreement was reached on the cooperative work between the national laboratories and the BIPM. This includes a critical study of the recent comparisons and plans for another intercomparison of a standard solution of ^{60}Co for testing the progress which will be made in the operating techniques. (BBB)

27220 SECULAR VARIATION OF ATMOSPHERIC RADIOCARBON CONCENTRATION. Kigoshi, Kunihiko (Gakushuin Univ., Tokyo). Nippon Kagaku Zasshi, 87: 209-20(Mar. 1966). (In Japanese).

The variation in atmospheric ^{14}C concentration during the last 1800 years was measured by the use of a giant tree grown on Yaku Island in southern Japan. The results of measurements showed ca 2% decrease of radiocarbon concentration during the past 1800 years. A general figure of the observed secular variation in atmospheric radiocarbon concentration agrees with a computed variation based on the variation in geomagnetic field strength in the past time. The possible variations in atmospheric radiocarbon caused by climate and nature of air masses are also discussed. An estimation of the effects of temperature on the carbon cycle and atmospheric radiocarbon concentration showed a possible decrease of the atmospheric radiocarbon concentration of ca 0.5% per 1°C increase of temperature. A systematic difference between radiocarbon concentrations in Yaku Sugi and Sequoia gigantea from California seems to suggest a lower radiocarbon concentration in the oceanic air masses than the continental air masses. (auth)

27221 EVALUATING THE DANGER OF UHF AND X-RAY RADIATION IN RADAR STATIONS. Ermolaev, E. A. Voenno-Med. Zh., No. 9, 22-6(1964).

The various parameters involved in the evaluation of uhf and x ray radiation intensities emitted by radar stations are discussed. Problems in dosimetry are reviewed. It is pointed out that the shielding of uhf installations can be accomplished by means of metal plates of such a thickness that the radiation level will be only one-tenth the minimum acceptable dose. It is concluded that underestimating the harmful effects of uhf and x ray fields could lead to harmful consequences for operators and technicians. On the other hand, proper evaluation of these factors will facilitate countermeasures. (CFSTI)

27222 SOME THOUGHTS ON THE STATUS OF ^{90}Sr CONTAMINATION IN THE AREA OF THE GERMAN DEMOCRATIC REPUBLIC. Schilling, Guenther; Richter, Dietmar (Univ., Jean, Ger.). Wiss. Z. Friedrich-Schiller-Univ., Jena, Math.-Naturwiss. Reihe, 14: 129-32(1965). (In German).

Data for ^{90}Sr contamination in plant samples taken from 1961 to 1963 are reviewed: clover grass, Jena, 20 ± 4 pC

$^{90}Sr/g$ Ca (1961); grass, Jena, 23 ± 2 (1961); grass, Eisenberg, 126 ± 23 (1961); spinach, Stadtroda, 116 ± 15 (1961); grass, Jena 63 (1962); red clover, Stadtroda, 281 ± 11 (1963); meadow, Stadtroda, 240 ± 13 (1963); spinach, Stadroda, 214 ± 17 (1963). An increase of the average contamination level from 65 pC $^{90}Sr/g$ Ca in 1961 to 245 pC $^{90}Sr/g$ Ca in 1963 was estimated. Causes of the variation are discussed. On the basis of the maximum permissible concentration, the levels of $^{90}Sr/g$ Ca in bone were estimated to be 13% of permissible concentration with a vegetable diet or 3.2% with a meat diet in 1961, and 49% with a vegetable diet or 12% with a meat diet in 1963. The population of East Germany is therefore not seriously endangered by contamination during these periods. From Jan. 1962 to Mar. 1963 the ^{90}Sr content of fallout in Jena averaged about 2000 pC $^{90}Sr/m^2$; for the next two quarters it was 6500 and 5000 pC/m^2 respectively, but in the last quarter of 1963 after cessation of testing it was less than 500 pC/m^2. (BBB)

27223 METHOD AND APPARATUS FOR PASSIVE DEFENSE FROM NUCLEAR EXPLOSIONS. Brown, Joseph; Spangenberg, Donald N. (to U. S. Navy). U. S. Patent 3,243,147. Mar. 29, 1966. Filed Mar. 31, 1965.

An apparatus and method are described for the passive defense of an aircraft to a near-miss nuclear explosion by means of which the direction of the explosion is detected and information is supplied to the aircraft automatic pilot to cause the aircraft to roll a discrete amount relative to the direction indicated, so that its least vulnerable aspect faces the location of the blast. A number of radiation sensors responsive to gamma radiation are mounted around the periphery of the fuselage of the plane to produce the signals indicative of the direction of blast. Additional sensors are arranged to view radial spaces about the fuselage to give substantially complete radiation surveillance. Discriminator means are connected to all the sensors to pass the strongest signal through to the automatic pilot. (B.L.M.)

INSTRUMENTATION

General

27224 (AERE-M-1729) SOME ADVANTAGES AND DISADVANTAGES OF A UNIT SYSTEM OF ELECTRONICS. Bisby, H. (Atomic Energy Research Establishment, Harwell (England)). Mar. 1966. 7p. Dep. BIS $0.30. HMSO 1s. 9d.

The dilemma of an Electronics Division, arising from reasonable user requirements, is highlighted and the reasons given why rationalization through a unit system of electronics, is necessary. The advantages and disadvantages of this solution are set out. (auth)

27225 (ANL-7072) ELECTRODE KINETICS. Elder, John P. (Argonne National Lab., Ill.). July 1965. Contract W-31-109-eng-38. 68p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

A discussion is presented on the fundamental tenets of electrode kinetics and the methods whereby the characteristic parameters of rapid-charge transfer processes at electrode-electrolyte interfaces are evaluated. Purposely, electroanalytical methods, which have resulted from techniques originally aimed at elucidating electrode mechanisms, such as polarography and its many ramifications, were not discussed. (M.O.W.)

27226 (ANL-7100) PROCEEDINGS OF THE CONFERENCE ON APPLICATION OF HIGH-TEMPERATURE INSTRUMENTATION TO LIQUID-METAL EXPERIMENTS, SEPTEMBER 28-29, 1965. (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 665p. (CONF-650946). Dep. mn. CFSTI $6.75 cy, $2.75 mn.

Twenty-nine papers were presented, separate abstracts were prepared for twenty-five. Four papers were previously abstracted in NSA; see papers under CONF-650946 in the report number index. (W.L.G.)

For abstracts of individual papers see: 26741, 27088-27104, 27128-27131, 27423, 27424, and 28826.

27227 (BNL-10214) GENERAL PURPOSE HUNDRED KILOJOULE PULSER. Forsyth, E. B. (Brookhaven National Lab., Upton, N. Y.). May 10, 1966. Contract AT(30-2)-Gen-16. 16p. (CONF-660528-1). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From 9th Modulator Symposium, Fort Monmouth, N. J.

Included are descriptions of the discharge circuit, module construction, trigger generators, charging supply, and fault and monitoring circuits. (M.O.W.)

27228 (LNF-66/12) COMPORTAMENTO DINAMICO DEI CIRCUITI MONOSTABILI A DIODO TUNNEL. (Dynamic Behavior of Tunnel Diode Monostable Circuits. Note No. 311). Abbattista, N.; Coli, M.; Plantamura, V. L. (Laboratori Nazionali di Frascati, Comitato Nazionale per l'Energia Nucleare (Italy)). Mar. 8, 1966. 17p. Dep. mn.

The dynamic behavior of tunnel diode monostable circuits is analyzed as a function of a characteristic parameter of the circuit. The analysis was developed in a general way and the results were applied with regard to the problems of fast nuclear electronics. It is referred to the circuits with current gain greater than one and to the circuits performing only a logic operation, and is comparative between the circuits with linear and nonlinear biasing. The circuits with tunnel biasing very near to the peak were regarded for multiple switching stability that is the most important limit for high sensitivity monostable circuits. (auth)

27229 (NYO-2983-1) RADIOISOTOPE GAGE FOR MONITORING SUSPENDED SEDIMENT CONCENTRATION IN RIVERS AND STREAMS. Sellers, Bach; Papadopoulos, John; Ziegler, Charles A. (Parametrics, Inc., Waltham, Mass.). Apr. 30, 1966. Contract AT(30-1)-2983. 63p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

For Engineering Drawings see CAPE-1432.

To satisfy the need for a self-powered, continuous monitoring system, a gage based on the use of radiation from a radioisotope source was developed. The advantages of using a radioisotope technique are discussed. The gage with a capacity for measuring sediment concentration over a concentration range of 1000 to 50,000 ppM of sediment was field tested. The gage is capable of operating and recording data unattended for a period of $7\frac{1}{2}$ days on internal power, and thus it constitutes a completely automatic monitoring station. The system consists of a weatherproof shore based control unit connected by 50 feet of waterproof cable to a submersible measuring head, which can be mounted on a wall or piling at any desired water depth. The entire system plus batteries can be transported by station wagon or jeep, and major system components can be carried by one man. The measuring head contains Cd-109 as the radioactive source. The source activity level is such that the unit may be shipped and handled without special procedures or markings. The theory of operation, error analysis, calibration methods and the operating procedures for using the gage in the field are presented. (P.C.H.)

27230 (RSIC-534) ELECTRONIC PACKAGING: A BIBLIOGRAPHY. Klapheke, J. W.; Veazie, W. H.; Holt, J. C.; Easterday, J. L. (Battelle Memorial Inst., Columbus, Ohio). Mar. 31, 1966. Contract DA-01-021-AMC-11706(Z). 85p.

References (476) are given to reports, journals, and manufacturers' literature published from 1953 through Jan. 1966. Subject indexing is provided by properties and environmental effects on packaging materials, discrete parts to module packaging, integrated circuits to module packaging, module packaging to assembly, housing and mounting, packaging products, and interconnection techniques. Author and corporate author indexes are included. (P.C.H.)

27231 (UCRL-14593) DEVELOPMENT AND APPLICATION OF THE INTRINSIC THERMOCOUPLE FOR FAST RESPONSE. Dittbenner, Gerald R. (Lawrence Radiation Lab., Univ. of California, Livermore). Mar. 9, 1966. Contract W-7405-eng-48. 11p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Fast-response thermocouples were developed by LRL to measure the temperature-time history of fissionable materials subjected to a pulsed neutron flux. The thermocouples were made of 0.001-in. and 0.0005-in. wire, flattened to a 200-μin.-thick ribbon. The two wires of each thermocouple are individually welded to the test specimen about $\frac{1}{32}$ in. apart so that the specimen completes the circuit and forms an intrinsic thermocouple installation. The 0.0005-in. thermocouple will stabilize at a normal indicated 100% of the test sample temperature in less than 1 msec after a quasi-step temperature change. This corresponds to an estimated time constant (63% of peak temperature) of about 20 μsec. (auth)

27232 SIX-LINE AUTOMATIC RECORDING UNIT. Babiloni, Luigi; Rispoli, Brunello; Serra, Antonio (CNEN-CSN, Casaccia, Italy). Comit. Naz. Energ. Nucl., Notiz., 12: No. 4, 58-63(Apr. 1966). (In Italian).

A recording unit with six counting lines, particularly suitable for experiments in nuclear physics is described. The unit can be used for measurements to predetermined times, numbers, or doses. The measuring and recording cycle is entirely automatic. (auth)

27233 NUCLEAR LEVEL GAGING. Loftin, Ronald L. (Ohmart Corp., Cincinnati). Instrum. Contr. Syst., 39: 115-17(Mar. 1966).

Use of nuclear level gaging systems to control and measure the level or interface position of liquids, solids, and slurries is described. They use the principle that the absorption of γ radiation by any material is a function of the mass of the material lying between the radiation source and the detector or measuring assembly. As the gaging

elements are not in contact with the material being measured, there is nothing to gum-up or clog, and the systems can provide level or interface recording, alarm, high- and low-level alarm, or full proportional control. Radium, cesium-137, and cobalt-60 are generally used as radioactive sources. They are supplied as a point source, a strip source, or multiple point sources. For relatively small vessels with thin walls, where only small quantities of radioactivity are required, radium is generally used. Cesium-137 is used where a larger quantity of radioactivity or strip sources are required, primarily due to its relatively low price. Cobalt-60 is preferable where high-penetration ability is required, as on vessels with thick steel or firebrick walls. It has a higher penetrating ability because of its higher-energy level γ radiation. Source holders are equipped with rotary shutters to cut off the radiation beam for vessel maintenance or cleaning. The source holders provide complete protection to operating personnel. When a γ source is mounted in a well, due to vessel size or wall thickness, a lead-shielded shipping and storage container is included to provide safe storage facilities if it is necessary to remove the source from the source well for vessel cleaning and maintenance. Various types of detectors are described and some applications of these gages are presented. (BBB)

27234 HIGH-INTENSITY ULTRAVIOLET LIGHT MONOCHROMATOR. Sayre, Robert M.; Straka, Emil Robert; Anglin, J. Hill Jr.; Everett, Mark Allen (Univ. of Oklahoma Medical Center, Oklahoma City). J. Invest. Dermatol., 45: 190-3(Sept. 1965).

A u-v monochromator with optical stability and good spectral purity in the range from 250 to 400 μ is described. The unit was developed to give graded doses of selected u-v frequencies to human subjects. It consists of a grating monochromator that is combined with a 2.5-kw source and a u-v reflecting ellipsoidal section. (D.C.W.)

27235 PROMISING APPROACH TO X-RAY REDUCTION IN HOT-FILAMENT IONIZATION GAUGES. Clay, Forrest P. Jr.; Melfi, Leonard T. Jr. (Langley Research Center, Hampton, Va.). J. Vac. Sci. Technol., 3: 167-8 (May-June 1965).

The design of a hot-filament ionization pressure gage is described. The performance of this gage is discussed in relation to that of the standard open-end Bayard-Alpert gage. The design and a two-dimensional field plot are shown for this ionization gage with a single buried collector. (J.F.P.)

27236 POWER SUPPLIES WITH VOLTAGE MONITORING. Friese, T. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Kerntechnik, 8: 177-9(Apr. 1966). (In German).

The circuits for power supplies with voltage monitoring, current limiting, and with over-current and over-voltage protection are given and their characteristics are discussed. (J.S.R.)

27237 MEASURING THE DENSITY OF THIN ASPHALT OR CONCRETE LAYERS WITH A GAMMA-RAY BACK-SCATTER APPARATUS. Harland, D. G. (Road Research Lab., Harmondsworth, Eng.). Nucl. Eng. Design, 3: 467-75(Apr. 1966).

One drawback of radioactive back-scatter apparatus for measuring density is the difficulty of defining adequately the depth-sampling characteristic. The concept of the mean depth to which useful gammas penetrate is introduced. Provided the instrument was designed to measure the absorption of back-scattered gamma radiation, the density determined in the presence of small density gradients will be average density of the layer lying above the mean depth. The derived density of this shallow layer may be slightly erratic due to the presence of layers with a different density at depths between one and three times the mean depth to which the gamma rays penetrate. Allowances are calculated for such errors for a particular instrument used in the experiments described. For this particular apparatus with a radium-226 source, the mean depth of penetration of the useful gamma radiation was found to be between 1.2 and 1.8 in. for materials with densities ranging from 150 to 100 lb/ft^3. This apparatus was found useful for measuring the increase of density during compaction of a 2½-in. asphalt base course, and for measuring the density variation near to the surface across layers of bituminous-bound materials. (auth)

27238 A PHOTOMULTIPLIER PULSE SHAPER WITH MINIMAL TIME SLEWING, INCORPORATING A TUNNEL DIODE CASCADE TRIGGER CIRCUIT. Verweij, H. (CERN, Geneva). Nucl. Instrum. Methods, 41: 181-9 (1966).

An instrument is described that converts signals from photomultipliers into pulses of standard amplitude (10 mA) and adjustable width (2.5–100 ns). It consists of an input shaping network, of which two versions are given, and a tunnel diode cascade trigger circuit. An attempt was made to reduce the time slewing to a minimum: with input pulses ranging from 10–160 mA, from a 56 AVP photomultiplier, it remains within ±0.25 ns. The instrument is capable of working up to frequencies of 150 Mc/sec. (auth)

27239 THEORETICAL STUDY OF COOLING OF IRONLESS COILS BY THERMAL CONDUCTIVITY PLATES. Mugnier, D.; Argou, P.; Lafoucriere, J. (Institut de Physique Nucleaire, Lyon). Nucl. Instrum. Methods, 41: 277-85(1966). (In French).

Practically, the cooling of ironless coils with current density varying from 5–10 A/mm^2, is often realized by juxtaposition of plane circular coils of wire and conducting copper plates cooled with a water circulation. This problem is first treated with a simplified theory. Then a more elaborate theory takes account of the thermal conductivity between the wires. With the help of an electric analogy, both the temperature and its gradient, are obtained in every point of the coil. (auth)

27240 USE OF DERANDOMIZERS FOR THE PREVENTION OF SPECTRUM DISTORTION. Arbel, A. F.; Suhami, A.; Sabbah, B. (Israel Inst. of Technology, Haifa). Nucl. Instrum. Methods, 41: 286-92(1966).

Distortion may occur in the case that two or more time-correlated peaks are present in a recorded spectrum. Such distortion may be reduced significantly by using a derandomizing analog or digital buffer. Several examples of such correlated spectra will be given together with suitable block diagrams. The resulting reduction of spectrum-distortion will be analyzed quantitatively. Finally, a short description will be given of the basic electronic circuit and its possible modification as a pulse stretcher, window amplifier, or combined derandomizer. As a pulse stretcher, the analysis of comparatively fast pulses by a slow ADC is made possible; as a window amplifier, the required bandwidth of the following circuits is significantly reduced by stretching the pulse before applying the bias; in the combined derandomizer and window amplifier, only those pulses reach the ADC whose amplitude exceeds the window bias. Pulses whose amplitude is smaller than the bias do not participate in the derandomizing process. (auth)

27241 NUCLEAR RESONANCE SYSTEM FOR MEASUREMENT AND STABILIZATION OF MAGNETIC FIELDS BETWEEN 0.1G AND 20 kG. Tatarczuk, J. R.; Ziegler, B. (Max-Planck-Institut fuer Chemie, Mainz). Nucl. Instrum. Methods, 41: 45-50(Apr. 1966). (In German).

A nuclear resonance system can be built which uses the same principal components as an atomic beam resonance apparatus whereby the atomic beam has been replaced by a flow of a liquid. The technique can be used for the measurement and stabilization of magnetic fields. Since the three fields for the polarization, measurement and detection of polarization are separated from each other the accuracy of the system is constant within a range from 0.1 G to 20 kG. Such a system is described and its properties and limitations are discussed. (auth)

27242 HIGH-SPEED CIRCUIT FOR STANDARDIZATION AND SELECTION OF PHOTOMULTIPLIER SIGNALS FOR TIME CONVERTERS. Izokh, V. V.; Chernyavskii, A. F. (Belorussian State Univ., Minsk). Prib. Tekh. Eksp., No. 6, 97-100(Nov.-Dec. 1965). (In Russian).

A circuit is proposed for shaping and selecting photomultiplier pulses for multichannel time analyzers. The device provides optimum time information in a wide dynamic range (0.05–10 volts) at a high average photomultiplier prf (minimum time between pulses $\geq 2.5 \cdot 10^{-8}$ sec). The circuit is based on tunnel diodes and transistors. A block diagram of the unit is given. The signals at the outputs have a constant amplitude of 0.6 volts and a duration of $2(10)^{-8}$ sec in a wide dynamic range of photomultiplier signals and may be used for direct triggering of time converters. A schematic diagram of the device is given, and the design and operation of the individual elements are briefly described. (ATD)

27243 DEMOUNTABLE HIGH-POWER SOURCE FOR SOFT X-RAY REGION. **Deslattes, Richard D.; Simson, Bert G. (National Bureau of Standards, Washington, D. C.). Rev. Sci. Instrum., 37: 753-4(June 1966).**

A demountable x-ray source capable of operation up to 3 kw is described. Construction is largely of stainless steel with elastomer seals. The source is of use in exciting secondary spectra and producing bremsstrahlung for absorption studies. (auth)

27244 TECHNIQUE FOR MEASURING MEGAGAUSS MAGNETIC FIELDS USING ZEEMAN EFFECT. **Garn, W. B.; Caird, R. S.; Thomson, D. B.; Fowler, C. M. (Los Alamos Scientific Lab., N. Mex.). Rev. Sci. Instrum., 37: 762-7(June 1966). (LA-DC-7651).**

Rapidly varying magnetic fields with peak values in the range from 1 to 5 MG are measured by use of a sweeping-image spectrographic method. Atomic spectral lines from an exploding-wire light source situated in the experimental region are recorded as the magnetic field varies in a few microseconds from a moderate initial value of a few tens of kilogauss to the peak values. Field measurements are generally accurate to within 2–3% as determined by the consistency of measurements made from several different spectral lines. The sodium D lines and the indium I 4102 Å line proved to be exceptionally useful for field determinations. The highest field determined to date by this method is 5.1 MG, corresponding to a measured separation of 164 Å between the centers of the shorter and longer wavelength doublets which the Na_D lines assume in very high fields. The doublets, of approximately 4Å separation, are not themselves resolved. (auth)

27245 MEASUREMENT OF THE PROBABILITY AND PULSE-HEIGHT DISTRIBUTION OF SECONDARY ELECTRON MULTIPLIER. **Brinkmann, E. (Univ., Mainz). Z. Phys., 192: 340-5(1966). (In German).**

The pulse height distribution of a CuBe-secondary electron multiplier was investigated under the action of single electrons. For an energy interval from 150 to 1000 ev the maximum pulse height increases with increasing electron energy (the energy corresponding to maximum yield being 365 ± 10 ev). This shows the statistics of secondary electron emission as being dependent on primary electron energy. (auth)

27246 TRANSISTORIZED PREAMPLIFIER/Q-2251/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1297).

3 drawings.

The voltage-sensitive bipolar-transitorized preamplifier can be used in deep small-diameter cavities or in remote locations with scintillation spectrometers. The components are attached to a $1\frac{5}{64}$ in. in dia printed-circuit board which can be rigidly fastened to a photomultiplier tube socket. Stray capacitance from the photomultiplier output circuit is controlled. The preamplifier circuit consists of 3 cascaded emitter-followers. The input resistance is greater than 1 meg Ω and the output resistance is adjustable from 50 to 150 Ω. The d-c power (2 ma at 18 v) is supplied through a coaxial cable. Signals are transmitted through cables up to 350 ft with negligible signal distortion. (For details, see TID-4100). (L.B.S.)

27247 SIGMA MOTOR PUMP DRIVE /Q-2252/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1298).

1 drawing.

This motor pump drive uses a General Radio Co. Motor, Model 21 to drive a Sigma-motor, Model T 63S. The system is used in a proportional river sampler. The pump operating at 19.8 rpm collects a 2.0 gal sample each day. (For details, see TID-4100.) (F.L.S.)

27248 FARADAY CUP /Q-2533/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1349).

3 drawings.

The Faraday cup was designed for calibrating an ionization chamber, which is used in proton beam monitoring in the range 10^5 to 10^{10} protons/sec. The cup consists of a 6 in. dia, 8 in. long Cu cylinder with a 4 in. dia, 6 in. long reentrant opening into which the proton beam is directed. The base of the cup is 45.2 g/cm² in thickness, which stops the incident 160-Mev proton beam. The cup is mounted in a brass housing on teflon rings, which isolate it electrically. A revised geometry to reduce scattering is included on Q-2533-3. (For details, see TID-4100.) (L.B.S.)

27249 RUBY LASER SYSTEM, 10 GIGAWATT (Engineering Materials). (Lawrence Radiation Lab., Univ. of California, Berkeley). (CAPE-1334).

32 drawings.

A ruby laser, which is used in experiments in high-temperature plasma research, is designed for hundreds of firings. It operates at 10-Gw. Twelve heads in a final amplifier provide enough beams to cover the surface of a sphere ½ mm in dia with a yield of 10 J each. The individual head contains 2 ruby rods 3 in. long and ½ in. in dia mounted in a die cast Al holder. The rubies are doped at 0.5% with 60° optic axis orientation. Included in the system are mirrors, beam splitters, collimating lenses, preamplifiers, amplifiers, Kerr cell, polarizer, oscillator, and a target sphere. The oscillator output is 1 J/cm² which is divided by a beam splitter, then directed by prisms through collimating lenses, 2 preamplifiers, prisms, beam splitters, and 12 final amplifiers. Prisms direct the final beams into the target chamber which can be evacuated to 10^{-6} torr or filled to 30 psig with a variety of gases. (For details, see TID-4100). (L.B.S.)

27250 MODIFIED A-8 AMPLIFIER /Q-2297/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1336).

1 drawing.

A transitorized, differential discrimator circuit used with Q-1819 an A-8 Linear Amplifier is described. The circuit includes two preamplifiers for use when high performance is not required and one for use when high performance is required. (For details, see TID-4100). (L.B.S.)

27251 PHYSICS OF QUANTUM ELECTRONICS. Conference Proceedings, San Juan, Puerto Rico, June 28–30, 1965. **Kelley, P. L.; Lax, B.; Tannenwald, P. E. (eds.). New York, McGraw-Hill Book Co., 1966. 883p. $24.00. (CONF-650638).**

A collection of papers is presented on the basic research in quantum electronics. Extensive coverage is devoted to nonlinear phenomena, including harmonic generation, mixing, stimulated Raman and Brillouin scattering, multiphoton absorption processes, and breakdown in gases. Also treated are spectroscopy with lasers, fundamental processes in gas lasers, and new gas laser sources. In addition solid-state laser materials, new laser schemes, energy transfer and relaxation processes, and magnetic field effects are covered. Semiconductor lasers are discussed in terms of the physical processes involved in injection, optical, and electron beam pumping. The theory of laser oscillations and the problems of coherence, noise, and measurement are presented. (B.G.D.)

27252 DEVICE FOR PRODUCTION OF A BUNCHED BEAM OF IONS OR ELECTRONS FOR AT LEAST TWO ANALOGOUS ION OR ELECTRON SOURCES ARRANGED IN SERIES. **Froehlich, Heinz (to Siemens-Schuckertwerke AG). German Patent 1,208,420. Jan. 5, 1966. Filed Nov. 20, 1962.**

A high-intensity ion or electron source is obtained by arranging at least two duoplasmatron sources in tandem in such a way that the space charge generated in the anode

opening of the preceding source is the virtual cathode of the following source. (Gmelin Inst.)

27253 DEVICE FOR PRODUCTION OF A BUNCHED ELECTRON BEAM OF HIGH POWER FOR HEATING PURPOSES. Bingel, Jakob. German Patent 1,208,830. Jan. 13, 1966. Filed June 12, 1963.

The electron gun comprises a cathode in the shape of a cylindrical cage, a Wehnelt electrode maintained at cathode potential and surrounding the cathode, and an anode plate with a hole in the center for the exit of the electrons. The cathode cage consists of parallel filaments or cylinders of oxide cathodes which are mounted on a circular plate, and of a hollow, metallic cylinder disposed in the axis of the cage and attached to the plate which is used for the current supply. (Gmelin Inst.)

27254 MEASUREMENT OF THE MASS OF A MATERIAL IN A CONTAINER BY RADIOACTIVE MEANS. Schafer, Curtiss R. (to Simmonds Precision Products Inc.). U. S. Patent 3,244,897. Apr. 5, 1966. Filed June 27, 1962.

A device with several embodiments is described for measuring the mass of material in a moving container or in an irregularly shaped container. The device is also applicable to the indication of the level of a liquid contained in an irregular container. The operation of the device is dependent upon the presence of the material to be measured between a radiation source and the radiation detector. For some applications, both the source and the detector take the form of strips that conform to the shape of the containing vessel. The device is particularly applicable for the determination of the weight of fuel contained in aircraft tanks at any particular time when the plane is in flight. In the determination of density of materials with this device, compensation for temperature induced density changes is provided. (B.L.M.)

27255 FAST ACTING SWITCH UTILIZING A VAPORIZABLE WIRE. Huber, H. J. (to U. S. Atomic Energy Commission). U. S. Patent 3,249,800. May 3, 1966.

This invention relates to a fast acting switch for discharging large amounts of current across said switch in a circuit. Spaced flat sided electrodes form a gap in the circuit having therein an insulator containing spaced foils connected by a thin conducting wire between the foils. The foils are energized explosively to vaporize the wire to provide a current path and large current discharge between the electrodes. Provision is also made for opening and closing the electrodes and moving an insulator having a plurality of exploding wires for repeated explosions in a recess between the electrodes for sequentially discharging said circuit without producing sputtered electrodes or adventitious discharges. (AEC)

Radiation Detection

Refer also to abstracts 26660, 26719, 26959, 27120, 27634, 28279, 28321, 28382, 28504, 28608, 28683, 28785, and 28836.

27256 (AD-627586) LOW-LEVEL ALPHA COUNTING: DESCRIPTION OF A DEVICE FOR INCREASING COUNTING EFFICIENCY ABOARD SUBMARINES. Report No. 453. Swengel, Richard M. (Naval Submarine Medical Center, Groton, Conn. Submarine Medical Research Lab.). June 7, 1965. 18p. CFSTI $1.00 cy, $0.50 mn.

The design and performance of a new device for increasing the low-level α counting efficiency of the standard AN/PDR-56 α Particle Meter is described. Directions for its construction, list of materials required, photographs, and diagrams are furnished. The practical application of shipboard utilization of such a device is pointed out. (STAR)

27257 (AWRE-O-24/66) AN INVESTIGATION INTO THE PRODUCTION OF NUCLEAR-COMPENSATED SILICON FOR USE IN NUCLEAR PARTICLE SPECTROMETERS. Gunnersen, E. M.; Ellis, R. (Atomic Weapons Research Establishment, Aldermaston (England)). May 1966. 29p. Dep. mn. BIS $0.90. HMSO 4s. 6d.

An experiment is described to irradiate high resistivity p-type silicon with thermal neutrons to obtain near intrinsic silicon with 10–50 μs minority carrier lifetime at room temperature. (auth)

27258 (CEA-R-2885) APPLICATION DES TECHNIQUES NOUVELLES DE L'ELECTRONIQUE RAPIDE A LA DETERMINATION DE L'INSTANT PRECIS DE DETECTION D'UNE PARTICULE [THESES]. (Application of New Fast-Electronic Techniques to the Determination of the Exact Moment of Particle Detection [Thesis]). Hesse, Michel (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 1966. 61p. Dep. mn.

Submitted to Lyon Univ., France.

Fluctuations in the time response of photomultipliers employed in scintillation counting are studied and experimentally checked. Statistical measurements of the output pulses show that the relative variance of the time fluctuations is minimum for the portion located around the bending point of the leading edge. A shaping circuit using this property is described. Experimental results are given, showing an improvement of the resolving time. (auth)

27259 (CERN-66-17) DETERMINATION OF PARTICLE MOMENTA IN SPARK CHAMBER AND COUNTER EXPERIMENTS. Griffiths, L.; Symons, C. R.; Zacharov, B. (European Organization for Nuclear Research, Geneva (Switzerland)). Apr. 21, 1966. 45p. Dep. mn.

A generalized, iterative, least squares method of fitting trajectories and determining momenta in spark chamber experiments was developed and tested successfully using a wide variety of experimental data. The specification of the field of the magnet used in the momenta determination was also investigated with the aid of various models and also by employing a detailed measured mesh of field values. (M.O.W.)

27260 (COO-1420-123) THE CALIBRATION OF THE PURDUE BROAD-RANGE, MAGNETIC SPECTROGRAPH AND THE INCIDENT-BEAM-ENERGY ANALYZING MAGNET. Bleuler, E.; Tendam, D. J.; Hemsky, J. W.; Wiley, C. L. (Purdue Research Foundation, Lafayette, Ind.). May 3, 1966. Contract AT(11-1)-1420. 98p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

The Purdue broad-range, magnetic spectrograph is a modified version of the high-resolution particle spectrographs designed and built at M.I.T. and at the University of Notre Dame. For magnetic-field strengths below 9.5 Kgauss, alpha particles from ^{210}Po were used to perform the energy calibration of the spectrograph focal surface. The validity of the resulting low-field energy-calibration equation for the spectrograph was investigated at higher magnetic-field strengths; and, within the limitations imposed by the fixed energy of the deuteron beam from the Purdue cyclotron, the low-field energy-calibration equation appears to be accurate to within 0.1% for magnetic-field strengths below 13.75 Kgauss. The average (energy) resolving power of the spectrograph focal surface is $1.2 \cdot 10^3$ for a 1° half-angle of acceptance and is $0.87 \cdot 10^3$ for a 3° half-angle of acceptance. The solid angle of the spectrograph in a $\frac{1}{2}$-inch by $\frac{5}{8}$-inch entrance mask and 0.418-inch exit mask configuration varies smoothly from 0.43 m sr at s = 0 cm to 0.30 m sr at s = 75 cm. By using the spectrograph low-field energy calibration as a standard, an energy-calibration equation for the incident-beam-energy analyzing magnet was obtained; the accuracy of the analyzing-magnet energy-calibration equation is 0.1%. (M.O.W.)

27261 (INR-686/III/E) NIEKTORE UWAGI DOTYCZAC WLASCIWOSCI DEKATRONOW EZ10B W SZYBKICH URZADZENIACH LICZACYCH. (Some Remarks Relative to Properties of the Dekatrons EZ10B in the Fast Computer Systems). Andrzejak, Ryszard; Wojtowicz, Stefan (Institute of Nuclear Research, Warsaw (Poland)). 1966. 8p. Dep.

Some remarks relative to properties of the dekatrons EZ10B adapted to the fast computer systems are given. Conclusions and experimental data obtained during elaboration of the fast counting problem with the above mentioned dekatrons are quoted. (auth)

27262 (JINR-P-2661) VLIYANIE FONOVOI ZAGRUZKI NA EFFEKTIVNOST ISKROVOI KAMERY. (Effect of Background Loading on Spark Chamber Efficiency). Vovenko, A. S.; Vyrenkova, M. Ya.; Gladki, Ya.; Gus'kov, B. N.; Lyubimov, A. L.; Savin, I. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1966. 8p. Dep. mn.

The efficiency of a multiplate spark chamber is investigated under conditions of large background loading. It is shown that the recording efficiency of "starting" particle falls, when the background particle has gone through the spark chamber after "starting" particle, but before the high-voltage pulse was applied to the chamber. The more is the time interval between the starting and background particles, the stronger is the effect of the background particles on the recording efficiency of the starting particles. An explanation of this dependence is given and recommendations are suggested to increase the spark chamber efficiency under unfavorable background conditions. (auth)

27263 (NAA-SR-11355) ANALOG COMPUTER FOR THE ARGON FLUX MONITOR. Kline, K. H. (Atomics International, Canoga Park, Calif.). May 25, 1966. Contract AT(11-1)-Gen-8. 21p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

An analog computer was designed and constructed for the purpose of solving any one of several equations to determine neutron flux by the activation of argon gas flowing through a piping system in a nuclear reactor. Inputs to the computer are from transducers measuring counting rate, pressure, mass flow, and temperature. (auth)

27264 (NP-15879) BESTIMMUNG VON γ-AKTIVITAETON MIT EINEM EINKANAL-SZINTILLATIONS-SPEKTROMETER AM BEISPIEL DES ^{137}Cs. (Determination of γ-Activity with a Single Channel Scintillation Spectrometer for Example ^{137}Cs [Thesis]). Paschke, Hartmut (Freie Universitaet, Berlin (West Germany). I. Physikalisches Institut). 1964. 38p. Dep. mn.

A scintillation single-channel spectrometer constructed for various individual devices was investigated. The special properties of a high voltage device, measurement heads, amplifier, and discriminator were given. At a high voltage of 1100 V energies up to at least 2 Kev could be measured. Linearity and long time stability were tested; the results showed that energy determinations are possible with an accuracy of ±1%. The energy resolution of the spectrometer for ^{137}Cs radiation is 9%. The dead time was determined as 2.80 μsec by the 2-source method. A formula for the calculation of the least pulse rate from the zero effect rate and for the conditions of the automatic taking of spectra were given. A general formula for the calculation of the activity from the measured integral pulse rate was given for the research installation used. The method of defined geometry was applied. The determination of the individual magnitudes occurring in the formulas was explained and numerically evaluated for the case of ^{137}Cs. The value of the NaI(Tl) efficiency obtained in measurement with a standard preparation determined for the crystal magnitudes used and broad parallel beam geometry agree with the calculated value within the limits of error. Activity determinations (at not too low activities) are possible with an error of ±3%. The minimum detectable ^{137}Cs activity is 2.5×10^{-3} μc. By variation of the geometry 1×10^{-4} μc could be detected which corresponds to the maximum permissible activity in a cubic cm of water. In this case the error is approximately 50%. (tr-auth)

27265 (PRNC-26) A SIMPLE DEVICE FOR THE AUTOMATIC ELIMINATION OF FATIGUE EFFECTS IN PHOTOMULTIPLIER TUBES. Cantarell, I.; Almodovar, I.; Cuadrado, S. (Puerto Rico Nuclear Center, Mayaguez). Oct. 1963. Contract AT(40-1)-1833. 23p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

Devices for the automatic elimination of fatigue effects influencing photomultiplier tube measurements are described. Either mechanical or electrical compensators can be used. The latter type consists of a logarithmic potentiometer and appears simpler in both construction and use. With the electrical compensator connected to a direct compensating circuit, and assisted by the mechanical inertia of the system, fatigue was reduced to about 1% of the original value without compensation. This degree of compensation requires an appropriate ratio between the compensating potentiometer resistance and load resistance; no additional, more sophisticated components are necessary for precision spectrometry. An auxiliary standard source is necessary for measurements of short-lived nuclides. (auth)

27266 (RHEL/R-114) CORRELATED DEAD TIME EFFECTS IN HIGH-RATE COINCIDENCE MEASUREMENTS. Gilmore, R. S.; O'Dell, A. W. (National Inst. for Research in Nuclear Science, Chilton (England). Rutherford High Energy Lab.). Dec. 1965. 14p. Dep. mn. BIS $0.50. HMSO 2s. 6d.

Correlated rates in electronic coincidences were expressed explicitly as subsets of sets which represent pulses in the logic system. They are shown to give rise to pseudo-random terms which may be evaluated or eliminated with electronic vetos. (auth)

27267 (TID-22844, pp 62-75) NEW INSTRUMENTATION PROGRAMS (PRIMARILY FOR NEUTRON CROSS SECTION MEASUREMENTS). (Rensselaer Polytechnic Inst., Troy, N. Y. Dept. of Nuclear Engineering and Science).

Brief summaries of research progress in the following areas of instrumentation development for neutron cross section measurements are presented: ^{10}B–NaI(Tl) detector for total neutron cross section measurements, multiplate Moxon-Rae detector development, automatic sample changer for 1.25 MTR capture gamma tank, sample changer for total cross section measurements, and the stored program data recorder. (M.O.W.)

27268 (UCRL-14293-T(Rev.1)) DESIGN FOR A VERSATILE CHARGE SENSITIVE PREAMPLIFIER FOR NUCLEAR RADIATION DETECTORS. Bradley, Arne E. (Lawrence Radiation Lab., Univ. of California, Livermore). Oct. 19, 1965. Contract W-7405-eng-48. 30p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

The design of the high-gain, low-noise, charge-sensitive preamplifier is discussed. This transistorized preamplifier has good versatility without sacrificing performance characteristics. The maximum gain is about 650 volts/picocoulomb, but can be reduced by a factor of 1200. The noise figure is approximately 300 rms electrons (2.6 kev fwhm referred to a silicon detector) at zero input capacitance and 1-μs pulse shaping. Either polarity input signal is accepted with a maximum output of either plus or minus 5 volts delivered to a 50-ohm load with better than 0.05% linearity. When desired, 1-μs integration and differentiation can be switch-selected to provide shaped pulses suitable for scalers or pulse height analyzers. Circuit design considerations to include frequency compensation, linearity, temperature stability, and bipolar operation are discussed. Graphs indicate preamplifier noise and risetime performance characteristics. A brief analysis describes charge-loop performance in terms of circuit parameters. A modified version of the preamplifier, which has provisions for removing the FET from the chassis and cooling it to about 130°K, has yielded a zero-input-capacitance noise figure of approximately 140 rms electrons (0.95 kev germanium). (auth)

27269 (CEA-tr-A-1871) POSSIBILITIES AND LIMITS OF THE USE OF VARIOUS METHODS OF INDIVIDUAL DOSIMETRY. Washsmann, F. Translated by M. Carbonnier (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires), from Zivilschutz, 28: 243-51 (1964). 43p. Dep. mn. JCL $4.60 fs, $1.52 mf.

The efficiency of the various methods used for dosimetry of x radiation was analyzed. Pocket ionization dosimeters can probably have only limited applications because of their sensitivity to shock and their high price. Chemical dosimeters and methods, that depend on alterations of the body of the object irradiated are not adequate and lack specificity. The thermal luminescent procedures for x-ray dosimetry offer no advantage over glass dosimeters. The glass and film dosimeters satisfy at the lowest cost all the measurement needs, but there is an important difference between these two systems. Film dosimeters permit a decentral-

ization of evaluation that cannot be realized with glass dosimeters. The choice between these two systems is only a question of availability. (tr-auth)

27270 $CO_2 + C_6H_{14}$ G-M COUNTER. Kopiczynski, T.; Moscicki, W.; Renk, H. (Technical Univ., Gdansk, Poland). Acta Phys. Pol., 29: 393-401(Mar. 1966).

The mixture of $CO_2 + C_6H_{14}$ (hexane) was tested as a gas for G-M counter designed for ^{14}C measurements. It was found that this mixture gives a very good result. For the counters filled to the total pressure between 100 and 700 mmHg the best results were obtained with admixture of 1.5% of hexane. The search was made for delay pulses. There were no delayed pulses in the time interval between 0.05 to 4.00 msec. The efficiency of the counter was estimated to be about 99%. (auth)

27271 OBTAINING INCREASED FOCAL DEPTH IN BUBBLE CHAMBER PHOTOGRAPHY BY AN APPLICATION OF THE HOLOGRAM PRINCIPLE. Welford, W. T. (Imperial Coll. of Sciences and Tech., London). Appl. Opt., 5: 872-3(May 1966).

A modification of the hologram technique that would give an increase in the focal depth but would not involve such severe mechanical and optical problems is discussed. This technique preferably would yield also a result looking much like an ordinary bubble chamber photograph, so as to facilitate the scanning and measuring process, but the information about out-of-focus bubble images would be encoded in a simple way. (B.G.D.)

27272 IMAGE-FORMING SLITLESS SPECTROMETER FOR SOFT X-RAY ASTRONOMY. Gursky, H.; Zehnpfennig, T. (American Science and Engineering, Inc., Cambridge, Mass.). Appl. Opt., 5: 875-6(May 1966).

The design of a slitless spectrometer that can produce spectral data of cosmic and solar x ray sources, simultaneously yielding high resolution spatial data is described. (B.G.D.)

27273 RECENT DEVELOPMENTS IN TRACE CHAMBERS FOR MEASUREMENT OF HIGH-ENERGY PARTICLES, AND A PROPOSAL FOR A NEW SYSTEM. Maeder, Daniel (Univ., Geneva). Arch. Sci. (Geneva), 18: 220-31(May-Aug. 1965). (In French).

A review of the general methods of detection of particles is given. Particular attention is paid to filament chambers. The universal system proposed by Giannelli with magnetostrictive filaments is discussed and illustrated. The system with auxiliary magnetostrictive filaments for reading proposed by Perez-Mendez is likewise illustrated. The electrode chamber with electromagnetic retarding lines proposed by Charpak is discussed. Ambiguities in the localization of multiple traces in these geometries are pointed out, and a new system which permits determination of x and y in one plane for several signals is proposed. The method for reconstruction of the positions of three events using this new system is illustrated for the general case and for three degenerate cases. The problem of insoluble ambiguities is greatly reduced by this method; a prototype of the system is under construction. It will be capable of reconstructing several events on a plane of area 0.1 m^2. (BBB)

27274 CONSTRUCTION OF A PROTON POLARIMETER. Gautschi, A.; Heer, E.; Levrat, B.; Maeder, D.; Renevey, J. F. (Univ., Geneva). Arch. Sci. (Geneva), 18: 232-42(May-Aug. 1965). (In French).

The construction of a proton polarimeter is described. Measurement of polarization by diffusion through C is described; construction of a polarimeter based on this principle is described and illustrated schematically. A diagram of the electronics of the polarimeter is given, with description of the operation mode. The optical arrangement of the system is also illustrated schematically. One of the first photographs was that of a 600-Mev proton in the graphite chambers of the polarimeter; the IBM 1620 computer reconstructs the paths in space and calculates true angles after correcting for optics on a punched tape system. Data may then be transferred to punch cards for statistical analysis. (BBB)

27275 ACTIVATION DETECTOR FOR THERMAL NEUTRONS. Tsetskhladze, T. V.; Fel'ker, V. M.; Kolomiitsev, M. A. At. Energ. (USSR), 20: 272-3(Mar. 1966). (In Russian).

A thermal-neutron activation detector is described with which neutron fluxes of the order of 10^{13} n/cm^2 can be measured. (G.O.Y.)

27276 PULSED MINIATURE FISSION CHAMBERS. Alekseev, V. I.; Egorov, O. K.; Konstantinov, L. V.; Postnikov, V. V. At. Energ. (USSR), 20: 273-5(Mar. 1966). (In Russian).

A fission chamber with a length of 160 mm and a diameter of 5.5 mm is described. Several variations of the basic design are proposed. (D.C.W.)

27277 SIMPLE MOESSBAUER SPECTROMETER. Bancroft, G. M.; Maddock, A. G.; Ward, J. (Cambridge Univ., Eng.). Chem. Ind. (London), No. 10, 423-5(Mar. 5, 1966).

A relatively inexpensive system was constructed from commercially available components which gave good resolution, linearity, and reproducible behavior. An electromechanical drive for the source, or absorber, operated in conjunction with a multichannel pulse analyzer driven in the multi-scaler mode gives more satisfactory spectra than spectrometers in which the pulses from the detector are modulated by the vibrator drive waveform and the multichannel analyzer operated in the pulse height analysis mode. The waveform of such a drive may be either an asymmetric or a symmetric saw tooth. The former allows all the channels to be used to store the spectrum. Advantages in using a symmetric wave and dividing the channels into two groups, thus duplicating the spectrum in each group, are cited. A schematic diagram of the complete spectrometer is shown. The circuit diagram of the integrator circuit is also shown. (TCO)

27278 COMPARISON OF THE ANGULAR OPENINGS OF PAIRS PRODUCED IN THE FIELD OF A NUCLEUS AND IN THE FIELD OF ATOMIC ELECTRON FOR THE NUCLEAR EMULSION ILFORD G-5. Castor, Jean; Augerat, Jacky; Berthot, Jacques (Laboratoire de Physique Nucleaire, Clermont-Ferrand, France). Compt. Rend., Ser. B, 262: 646-9(Feb. 28, 1966). (In French).

It is shown that there is no significant difference between the angular openings of pairs and that of triplets in the Ilford G-5 nuclear emulsion. (tr-auth)

27279 ESTIMATION OF THE NUMBER OF FALSE TRIPLETS AND CALCULATION OF THE RATIO OF THE NUMBER OF TRIPLETS TO THE NUMBER OF PAIRS IN THE ILFORD G_5 NUCLEAR EMULSIONS. Augerat, Jacky; Castor, Jean; Bertin, Pierre-Yves (Faculte des Sciences, Clermont-Ferrand, France). Compt. Rend., Ser. B, 262: 835-7(Mar. 21, 1966). (In French).

A thorough examination of the materialization events was made and a method is given for the evaluation for the number of false triplets. A comparison between the experimental ratio of the number of triplets to the number of pairs and the ratio predicted by the theory is then possible. (tr-auth)

27280 EXPERIMENTAL DETERMINATION OF SCATTERED RADIATION BY MEANS OF A FILM DETECTOR. Balazovskii, M. Ya. (Sverdlovsk Pedagogical Inst., USSR). Defektoskopiya, No. 6, 47-50(1965). (In Russian).

The method for the determination of the factor of scattered radiation by means of film detectors was described. It was shown that the dependence of the factor on the radiation hardness has a maximum. For small thicknesses of the object the maximum was observed at radiation hardness of 200 kv and was displaced to the right with increase of the thickness of the translucent film. (tr-auth)

27281 DIFFERENTIAL MAGNETIC ANALYZER OF LOW-ENERGY ELECTRONS AND PROTONS. Maduev, V. L.; Savenko, I. A.; Tel'tsov, M. V. (Moscow State Univ.). Geomagn. Aeronomy (USSR)(Engl. Transl.), 5: 749-50 (1965).

Translated from Geomagn. Aeronomiya, 5: 950-1(1965).

A simple particle counter is described which records selected energy ranges of trapped geomagnetic radiation. Electrons in the range of 25–120 kev and protons in the range of 0.5–3 Mev are registered in three tandem counter stages, so that differential counter readings give a spectral breakdown of energies. The counters are identical in form, each having a funnel-shaped input collimator with transverse baffles. The input counter has a mica window which passes electrons of >25 kev and protons of >0.5 Mev; counter 2 uses a permanent magnetic field to eliminate electrons below 50 kev; counter 3 uses an identical magnetic field plus an aluminum foil window, thus providing a cutoff level of 120 kev and 3 Mev for electrons and protons, respectively. The field in the gap is approximately 400 oe. Type SBT-9 gas discharge counter elements are used. The entire assembly weighs 15 grams. (ATD)

27282 MEASURING THE CURRENT IN A PULSED BEAM OF CHARGED PARTICLES. Armenskii, E. V.; Rybin, V. M. Izmeritel. Tekh., No. 2, 13-7(Feb. 1966). (In Russian).

Three types of charged-particle, pulse converters are reviewed. A Faraday cylinder sufficiently thick to absorb all the charged particles is designated as a nontransparent converter. It gives an absolute measure of the beam current. Errors due to leakage and reflection can be eliminated by proper design and construction. Currents from 10^{-8} to 10^{-13} amps at particle energies of 30 to 100 Mev can be measured with accuracies of 0.5 to 1.0%. The second type of converter employs various kinds of collimators, and measures only a fraction of the current. This type of converter must be accurately and frequently calibrated by means of a Faraday cylinder. The third type of converter is called a transparent converter which can be further subdivided into contact and contact-free kinds. The contact type depends on secondary electron emission from aluminum foil. The amount of secondary electron emission is proportioned to the primary current. Measurements are carried out at average beam currents of 10^{-8} to 10^{-9} amps at energies of 10 to 100 Mev, and at currents of 10^{-8} to 10^{-10} amps at particle energies up to 2000 Mev. The contact-free converters depend on electromagnetic induction. (TTT)

27283 TWIN ISOTHERMAL GAMMA CALORIMETER WITH THERMISTORS. Kovar, Zdenek; Handl, Josef (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Prague). Jad. Energ., 12: 121-6(1966). (In Czech).

The construction of a calorimetric assembly suitable as fundamental laboratory equipment for activity standardization measurements of γ sources is described. The twin isothermal calorimeter with lead absorbing bodies is suspended in a thermostating oil bath and continuously evacuated. Thermistors are used as temperature sensitive elements. A relatively simple method of measurement and results of electric power calibration are presented. The sensitivity of calorimeter is $7.42(10)^{-2}$ deg per milliwatt. The verification measurements of ^{60}Co sample activities have proved that the new reported modification of isothermal calorimeter allows measuring activities of ^{60}Co from 20 mC and with accuracy up to 1 per cent. (auth)

27284 SIMPLE METHOD FOR DETERMINING THERMAL NEUTRON DISTRIBUTIONS. Deme, S.; Feher, I. (Zentralforschungsinstitut fuer Physik, Budapest). Kernenergie, 9: 54-7(Feb. 1966). (In German).

A simple activation autoradiography method for studying the radial intensity distribution of thermal neutron beams is described which allows the distribution of thermal neutrons with a flux higher than 5×10^3 n/cm^2 sec to be determined with a relative accuracy of 5 to 10% by utilizing exposed foils. As an example, the results obtained by measurements of the collimated neutron beam leaving a horizontal channel of the experimental reactor WWR-S are given. (auth)

27285 THE SPARK CHAMBER. PART I. Truemper, J. (Christian-Albrechts-Univ., Kiel). Kerntechnik, 8: 184-7(Apr. 1966). (In German).

The principle of the spark chamber is discussed. The gas discharge mechanism, the spark chamber construction, and the properties of spark chambers are summarized. (J.S.R.)

27286 ARRAY OF POSITION SENSITIVE SURFACE BARRIER DETECTORS FOR USE IN A BROAD RANGE MAGNETIC SPECTROGRAPH. Bock, R.; Duhm, H. H.; Melzer, W.; Puehlhofer, F.; Stadler, B. (Max Planck Institut fuer Kernphysik, Heidelberg). Nucl. Instrum. Methods, 41: 190-4(1966).

Position sensitive surface barrier detectors were developed with an effective length of 5 cm. The position dependent signal is linear within 1% and the resolution obtained is better than 1 mm for particles of 10 Mev. For use in a magnetic spectrograph these detectors were combined to a multidetector array. The energy and the position pulses are stored in a two dimensional multichannel analyzer. The electronic equipment is described. A device of 6 detector elements was checked in the spectrograph and two spectra of the ^{27}Al(d,d′) and ^{27}Al(d,α) reactions are shown, which are measured simultaneously. (auth)

27287 AUTOMATIC FOLLOWING MICROSCOPE. Cox, J.; Duff, M. J. B.; Townsend, L. J. (University College, London). Nucl. Instrum. Methods, 41: 195-207(1966).

An automatic following microscope for use in the analysis of nuclear emulsion is described. The design incorporates certain features of an earlier prototype. The complete system will search for, find, follow and read co-ordinates of black, grey and minimum tracks, with following speeds of up to 10 mm/minute. (auth)

27288 HEAVY ION REACTION PRODUCT IDENTIFICATION BY MEASUREMENT OF dE/dx AND E. Sachs, M. W.; Chasman, C.; Bromley, D. A. (Yale Univ., New Haven, Conn.). Nucl. Instrum. Methods, 41: 213-25(1966).

A complete system for the identification and energy measurement of heavy-ion reaction products is described. The system, based on sequential measurement of specific ionization, dE/dx and energy, E, is capable of resolving the isotopes of all elements at least as heavy as oxygen. The electronic system is based on an analog pulse multiplier which is described in detail. The effect of ionic charge state distributions on these measurements is considered. (auth)

27289 METHOD FOR TIME-ENERGY MEASUREMENTS. Papadopoulos, L. (Nuclear Research Center, Democritus, Athens). Nucl. Instrum. Methods, 41: 241-4(1966).

A method is suggested, which will be a solution to the problem of time-energy measurements, without affecting the energy resolution. (auth)

27290 USING THE ^{28}Si(n,q) INTERACTION IN FAST NEUTRON SPECTROSCOPY. Shannon, J. A.; Trice, J. B. (General Electric Co., Valley Forge, Pa.). Nucl. Instrum. Methods, 41: 255-60(1966).

Recently the cross sections of the neutron disintegration of ^{28}Si have become available. The primary Si(n,q) breakup to the ground state of the residual nucleus and secondary modes of breakup to excited states are also known. For any given energy interval the neutron flux incident on a silicon semiconductor detector may be calculated by observing the charged particle flux corresponding to the Q-value of the reaction. The primary mode of breakup is ^{28}Si(n,p_0 + p_1) or ^{28}Si(n,α_0) according as the neutron energy is less or greater than 8.5 Mev. Corrections for disintegrations to secondary modes of breakup must be taken into account. The energetics of the interaction limit this method to energies greater than 5 Mev. Present limitations on our knowledge of the appropriate cross sections indicate than an upper energy limit of 10.2 Mev is appropriate but may be removed by further knowledge of the silicon-neutron disintegration. As an example of the method the Pu–Be spectrum is calculated with ΔE_n = 400 kev. (auth)

27291 BEHAVIOR UNDER GAMMA IRRADIATION OF CYLINDRICAL IONIZATION CHAMBERS FILLED WITH LIQUID HEXANE. Blanc, D. (Centre de Physique Nucleaire de la Faculte des Sciences, Toulouse); Mathieu, J.;

Patau, J. P.; Francois, H.; Soudain, G. Nucl. Instrum. Methods, 41: 272-6(1966). (In French).

By the use of a cylindrical geometry, stable detectors are obtained with a large sensitive volume. As it was the case with parallel geometry, the ionization currents vs the electrical field are straight lines which would, if prolonged, intersect in a point of the field axis, which is characteristic of the nature of the incident particles. The influence of the geometry on the sensitivity of the detector and the best value of the ratio of the diameters of the electrodes is deduced. These chambers are used in practical dosimetry of gamma radiation. The prototype (sensitive volume: 80 cm^3) shows a sensitivity of 5×10^{-7} rad/sec. (auth)

27292 ELECTRON SCINTILLATION DETECTOR WITH GOOD ENERGY RESOLUTION. Sparrman, P.; Lindskog, J.; Marelius, A. (Univ. of Uppsala). Nucl. Instrum. Methods, 41: 299-304(1966).

The construction and performance of an electron scintillation detector to be used in a magnetic β-spectrometer is described. An energy resolution close to the theoretical limit is achieved. The strong influence on pulse amplitude resolution of geometrical shapes of scintillator and light guide is shown. (auth)

27293 TRACING OF RELATIVISTIC ELECTRONS IN ELECTRICAL FIELDS BY A NUMERICAL METHOD. Sparrman, P. (Uppsala Univ.). Nucl. Instrum. Methods, 41: 305-8(1966).

A numerical method for the calculation of the potential distributions for axial symmetry and methods for tracing the electron trajectories in such fields are described. Applications to an electron-electron coincidence spectrometer are discussed. (auth)

27294 OPERATIONAL CHARACTERISTICS OF A WIDE GAP SPARK CHAMBER. Keller, L. P. (Argonne National Lab., Ill.); Schluter, R. A.; White, T. O. Nucl. Instrum. Methods, 41: 309-18(1966).

A comprehensive set of operational characteristics was determined for a spark chamber containing 4″-gaps and operating in the spark mode: The addition of ethyl alcohol or other organic compounds to the usual spark chamber gas mixture has improved track quality by almost a factor of two. Track brightness was determined as a function of angle and ethyl alcohol concentration. Chamber operation was shown to be unaffected by a 15 kG magnetic field parallel to the chamber's electric field. Precision measurements confirmed tracking to within ~1 mrad in angle and ~0.2 mm in position over the entire 0-40° track angle range. Recovery time studies showed the chamber to be capable of displaying successive tracks in firings separated by intervals down to the minimum investigated: ~30 msec. Successful operation of the chamber in a beam of 2×10^6 minimum ionizing particles is reported and a sensitive time of a few μsec was found. Spatial reconstruction of scattering vertices located 8″ outside the chamber has also been carried out with the resulting distances of closest approach being <0.5 mm and consistent with zero. Finally, a simple technique was found to render a region of the chamber totally insensitive to beam tracks. (auth)

27295 EFFECT OF DEADTIME ON COUNTING ERRORS. Cohn, C. E. (Argonne National Lab., Ill.). Nucl. Instrum. Methods, 41: 338-40(1966).

Count-rate error estimates, as well as the count-rate estimates themselves, require correction for deadtime effects. These corrections are studied for the simple non-paralyzable and paralyzable counter models. It is shown that the maximum worthwhile source count rate (from the standpoint of statistical error reduction) is approximately the reciprocal of the deadtime for a non-paralyzable counter and about one-tenth of this for a paralyzable counter. (auth)

27296 SIMPLE METHOD OF RECORDING SPARK CHAMBER EVENTS. Quercigh, E. (Univ., Milan). Nucl. Instrum. Methods, 41: 355-6(1966).

A spark chamber model using a series of condensers for recording and localizing sparks is proposed. Tests were first made on a model of a chamber with a single condenser in series with the electrodes in an atmosphere of argon. The advantages of the recording method are pointed out for use in balloon and satellite cosmic-ray experiments. (L.B.S.)

27297 REMARKS ON A NEW METHOD OF TRACK RECORDING OF SPARK CHAMBER ON MAGNETIC THIN FILMS. Quercigh, E. (Univ., Milan). Nucl. Instrum. Methods, 41: 357(1966).

An investigation of the degree of resolution afforded by the method of direct recording of spark chamber tracks on magnetic tape showed the capability of attaining image-width values comparable to those obtainable by other filmless methods. (L.B.S.)

27298 ANALYSIS OF TWO-DIMENSIONAL COINCIDENCE SPECTRA. Slavinskas, D. D.; Kennett, T. J.; Prestwich, W. V.; Keech, G. L. (McMaster Univ., Hamilton, Ont.). Nucl. Instrum. Methods, 41: 1-12(Apr. 1966).

A model is presented for spectra obtained with two detectors in coincidence. Two methods of solution for the significant parameters are discussed. The first method is a full least squares solution which may lead to the inversion of an impractically large matrix. The second method avoids this difficulty by breaking up the solution into parts. Covariance matrices are derived for both methods of solution. A study of various least squares weighting estimates is also presented. (auth)

27299 PULSE SPECTRA OF SINGLE PHOTOELECTRONS. II. METHOD OF MEASUREMENT OF WEAK LUMINOUS FLUX AND SELECTION OF PHOTOMULTIPLIERS. Duquesne, M.; Tatischeff, I.; Recouvreur, N. (Univ., Paris). Nucl. Instrum. Methods, 41: 13-29(Apr. 1966). (In French).

A definition of a weak light flux is presented. Two methods of detection, pulse technique and anode current measurement, are discussed and comparisons are made with regards to their respective advantages, relative accuracies, and sensitivity limit. The best conditions for detecting weak light fluxes are described. The selection of photomultipliers able to detect single photoelectron pulses is also discussed. (auth)

27300 Ge(Li) GAMMA SPECTROMETER EMPLOYING AN ANTI-COMPTON MANTLE OF NaI(Tl). Kantele, J.; Suominen, P. (Univ. of Helsinki). Nucl. Instrum. Methods, 41: 41-4(Apr. 1966).

An anti-Compton spectrometer employing a Ge(Li) detector surrounded by a large (20 cm by 30 cm) NaI(Tl) annulus is described. The system also includes a smaller annular crystal of NaI(Tl) which detects degraded gammas scattered from the germanium detector in the backward direction. The cryostat and the vacuum chamber of the spectrometer are constructed to give a large reduction of the Compton tails of gamma spectra when the system is operated in the anti-Compton mode. The reduction of the tail of the ^{60}Co spectrum near the Compton edge of the 1.17 Mev gamma is approximately 16 and the average reduction in the region above 0.3 Mev is nearly 10. The use of the spectrometer configuration as a pair spectrometer is also proposed. (auth)

27301 BACKSCATTERING OF 1-Mev ELECTRONS FROM SILICON. Rester, D. H.; Rainwater, W. J. Jr. (Ling-Temco-Vought, Inc., Dallas). Contract NASw-948. Nucl. Instrum. Methods, 41: 51-5(Apr. 1966).

Measurements of energy spectra and the angular distributions of perpendicularly incident 1 Mev electrons backscattered from a saturation thickness of Si are reported. The energy spectra were accumulated with a 2 mm lithium-ion-drift silicon (LIDS) detector. By taking spectra at eight angles ranging from 102.5–162.5° it was possible to integrate accurately over energy and solid angle to obtain the backscattered fraction of the incident beam. The value determined is 0.09. The present measurements are compared to the most recent experimental and calculated values of the backscatter for Al. The backscatter spectra from Si are also compared to the so-called low energy tail of the response to monoenergetic electrons of the LIDS detector. (auth)

27302 PHOTO DIGIT: PHOTOELECTRIC DIGITALIZED METHOD FOR SPARK CHAMBER DATA EXTRAC-

TION. Diambrini, G. (Univ., Genoa. Istituto Nazionale di Fisica Nucleare, Genoa); Giannini, I. Nucl. Instrum. Methods, 41: 56-60(Apr. 1966).

A new method for the simultaneous extraction of the data from a spark chamber has been studied and tested. A simple device detects the light from the sparks by means of photodiodes and a special optical system in such a way as to get a digitalized information on the position of the sparks. The error in the localization of the spark in a gap can be easily confined at ±0.5 mm. (auth)

27303 INSTRUMENTATION OF A MANUALLY PROGRAMMED NEUTRON DIFFRACTOMETER. Hansen, K. B.; Neisig, K. E. (Danish Atomic Energy Commission, Roskilde). Nucl. Instrum. Methods, 41: 61-8(Apr. 1966).

The digital part of the instrumentation for a neutron diffractometer in which the measuring procedure is governed by a control unit involving a fixed number of program points is described. A simultaneously running test program monitors the information transfer from the data sources and to the print-out in table form. The experimental conditions must be set by a panel switch selected program, which allows a desired parameter program to be executed. (auth)

27304 SENSITIVE TIME OF A WIDE GAP SPARK CHAMBER. Eisenstein, B.; Grossman, D.; Sah, R.; Strauch, K. (Harvard Univ., Cambridge, Mass.). Nucl. Instrum. Methods, 41: 69-72(Apr. 1966).

The sensitive time of a typical 40 cm wide gap chamber operated in the spark mode and filled with 90% Ne–10% He at 1.1 atm has been determined using 158 Mev protons. It is found that the efficiency for obtaining good tracks is >98% when two or three particles arrive within 0.5 μsec of the application of the high voltage pulse and that this efficiency decreases rapidly with arrival times larger than 0.5 μsec. (auth)

27305 USE OF A NITROGEN POLARIMETER AS A POLARIZED PROTON DETECTOR. Steben, J. D.; Brussel, M. K. (Univ. of Illinois, Urbana). Nucl. Instrum. Methods, 41: 73-6(Apr. 1966).

The ability of ^{14}N to produce a 60% polarization in a beam of protons elastically scattered at $45°_{lab}$, for incident proton energies between 8 and 12 Mev, makes nitrogen attractive as a proton polarization analyzer. Because of the 3–4% energy resolution obtainable with 10^{-2} Sr solid angles and the absence of isospin-zero excited states below 3.95 Mev in ^{14}N, a 45° nitrogen polarimeter would be especially suitable for resolving proton groups close in energy, such as would occur in (p,p′) or (d,p) reactions on nuclei in the mass range A = 40 to 70. (auth)

27306 24 POSITION TARGET CHAMBER FOR OBSERVATION OF β AND γ RAYS. Jensen, B.; Nelson, J. W. (Florida State Univ., Tallahassee). Nucl. Instrum. Methods, 41: 84-8(Apr. 1966).

A target chamber which holds 24 backed targets has been designed and constructed for observation of β and γ rays. Provision is made for efficient counting within the vacuum chamber at 90° with scintillators up to 5 cm in dia. and outside the vacuum at 45° where larger scintillators may be used. A motor rotates the targets into bombardment position where they are struck by the beam at a 45° angle. All targets are visible from the back side and the front side of the target in bombardment position may also be seen. Typical results from experiments performed with the aid of the chamber are given. (auth)

27307 SOME REMARKS ON THE PROPERTIES OF SMALL ORGANIC SCINTILLATORS AS DETECTORS OF FAST NEUTRONS. Schwarz, S.; Zetterstroem, H. O. (Research Inst. of National Defense, Stockholm). Nucl. Instrum. Methods, 41: 93-9(Apr. 1966).

A review is given of the effects that determine the spectra from small organic scintillators in response to monoenergetic fast neutrons. Numerical results are given for the plastic scintillator NE 150. (auth)

27308 CURRENT SPARK CHAMBER USED AS A SEVERAL HUNDRED CHANNEL LADDER COUNTER. Jeanjean, J.; Lefrancois, J.; Perez-Y-Jorba, J. (Univ. Paris, Orsay, France). Nucl. Instrum. Methods, 41: 100-8(Apr. 1966).

A spark chamber where a current signal is used to measure the position of the spark was developed for the purpose of its use as a several hundred channel ladder counter associated with a magnetic spectrometer. The main characteristics of the chamber were first determined with a β ray source and with cosmic rays. The linearity, the resolution of the instrument and the accuracy on the localization of the sparks were studied. An attempt was made to obtain a counting efficiency as close as possible to 100%. The overall characteristics of the system were then checked on a magnetic spectrometer by studying the scattering of high energy electrons on ^{9}Be. (auth)

27309 BROAD-RANGE HIGH-TRANSMISSION ELECTRON SPECTROMETER. Burginyon, G. A.; Greenberg, J. S. (Yale Univ., New Haven). Nucl. Instrum. Methods, 41: 109-14(Apr. 1966). (YALE-2726-HIA-75).

A high-transmission, broad-range electron spectrometer has been developed to study internal conversion electrons from the deexcitation of levels populated by Coulomb excitation. A solenoidal magnetic field configuration is used to transport the electrons away from the target and focus them onto a cooled semiconductor detector. In principle, the effiency ranges from nearly 50% at 100 kev to approximately 15% at a few Mev and the broad-range character is effectively limited by the dynamic range of the recording electronic equipment associated with the semiconductor counter. Compton-scattering background events in the detector from gamma radiation originating in the target are greatly attenuated by large detector-target separation with small sacrifice to the electron collection efficiency. This spectrometer is particularly useful in experiments involving low data accumulation rates, and it can be readily employed in a coincidence configuration. Data obtained from Coulomb excitation experiments with heavy ions and from radioactive sources are presented. (auth)

27310 COUNTER TELESCOPE SYSTEM FOR CHARGED PHOTOPARTICLES. Scanlon, P. J.; Janzen, H. (Queen's Univ., Kingston, Ont.). Nucl. Instrum. Methods, 41: 115-21(Apr. 1966).

A solid state dE/dx,E telescope system is described together with simple instrumentation, equivalent to a pulse height analyzer with 10^4 channels, to record two-parameter data. The recorded data are readily available for computer analysis. Results are shown for measurements on pulses from heavy charged photoparticles produced in the presence of a high background of small pulses from scattered radiation and obtained by irradiating a high Z target (^{165}Ho) with x rays from a 70-Mev electron synchrotron. A tunnel diode zero cross-over coincidence circuit and a pair of linear gates are used to eliminate the background pulses. Particle identification is made by computer analysis. Protons, deuterons and tritons, are clearly separated at proton energies as low as 6.5 Mev. A simple extension of the system could be used with an array of telescopes to eliminate the need for several large analyzers in simultaneous measurements of the energies and angular distributions of charged photoparticles. (auth)

27311 FINITE GEOMETRY CORRECTION FOR DIFFERENTIAL SCATTERING CROSS SECTION EXPERIMENTS. Willmes, H. (Univ. of California, Los Angeles). Contract Nonr 233(44). Nucl. Instrum. Methods, 41: 122-4(Apr. 1966).

A correction formula for the effect of finite geometry is developed for measurements of differential scattering cross sections. In addition to the finite sizes of target and detector, the angular spread of the incident beam is considered. (auth)

27312 RING-FOCUS IN A LONG SOLENOID BETA-RAY SPECTROMETER, EQUIPPED WITH AN AXIAL MAGNETIC DIPOLE AS DIVERGENT LENS. Muscia, C. (Istituto Nazionale per le Applicazioni del Calcolo, Rome). Nucl. Instrum. Methods, 41: 125-8(Apr. 1966).

Persico's paper, about a magnetic dipole as divergent

electron lens and the experiments by Hubert et al., fitting a corrective magnetic dipole on the axis and on the median plane in Ivry's solenoid spectrometer, are recalled. The electron-optics differential equation, related to a particular configuration and numerically integrated, shows the formation of two ring-focus with intermediate image. In theory compared with a normal solenoid spectrometer, the dipole spectrometer seems to offer less aberrations and better resolving power. The practical construction of the instrument is also mentioned. (auth)

27313 RECONSTRUCTION OF CONTINUOUS GAMMA-RAY SPECTRA. Su, Yung Sung (National Taiwan Univ., Taipei); Wu, Tsu-Chih. Nucl. Instrum. Methods, 41: 129-32(Apr. 1966).

A new approach with general treatment and application on the reconstruction of continuous gamma spectra is proposed for further investigation. The proposal is generated from the concept of linear measurement and may possess the advantages of avoiding the oscillation of constructed spectra, the error of normalization and interpolation and the limitation of available standards. (auth)

27314 USE OF A POSITION SENSITIVE SURFACE BARRIER PARTICLE DETECTOR FOR KINEMATIC COMPENSATION IN HEAVY ION REACTIONS. Broude, C.; Ollerhead, R. W. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Instrum. Methods, 41: 135-7(Apr. 1966).

A radially position sensitive surface barrier particle detector has been used to detect α particles from heavy ion reactions, in which the α energy changes rapidly with angle of observation (~50 kev/degree) due to the high center of mass velocity. The position signal, equivalent to a measure of angle of emission, has been used to derive a correction for this large energy spread of the emitted particles, thus permitting large solid angle (~280 msterad) with an effective resolution (~150 kev) appropriate to solid angles about ten times smaller. (auth)

27315 POTENTIAL USE OF AUGER ELECTRONS FOR COINCIDENCE MEASUREMENTS OF NUCLEAR QUANTITIES. Sparrman, P.; Sundstroem, T.; Marelius, A. (Uppsala Univ.). Nucl. Instrum. Methods, 41: 138-40(Apr. 1966).

Measurements involving Auger electrons and x rays in coincidence with K and L shell conversions are discussed. A new technique for determining K shell conversion and capture probabilities and other nuclear properties is presented. (B.G.D.)

27316 USE OF A NANOSECOND TIME GATED Li-Ge DETECTOR FOR MEASURING DE-EXCITATION GAMMA RAYS FROM FAST NEUTRON SCATTERING. Beghian, L. E.; Hofmann, F.; Wilensky, S. (Massachusetts Inst. of Tech., Cambridge). Nucl. Instrum. Methods, 41: 141-4 (Apr. 1966).

A description of a lithium-drifted germanium detector utilizing the timing capability to be operated with a resolution of approximately 10^{-8} sec. For gamma pulses $\geq$200 kev is presented. The time gated gamma ray spectrometer was used to measure the excitation function of two gamma rays from niobium. (B.G.D.)

27317 NUCLEAR PLATE CAMERA FOR GAS AND SOLID TARGETS. Hossain, A. (Atomic Energy Centre, Dacca, Pakistan); Khan, A. H.; Sen Gupta, H. M. Nucl. Instrum. Methods, 41: 145-6(Apr. 1966).

The design and construction are given of a camera with nuclear emulsion as detector for precise measurements of angular distribution of charged particles, from nuclear scattering processes in gas and solid targets. (B.G.D.)

27318 CIRCUIT FOR REJECTING PILE-UP PULSES. Fuschini, E.; Maroni, C.; Veronesi, P. (Univ., Bologna). Nucl. Instrum. Methods, 41: 153-5(Apr. 1966).

In measurements with time to amplitude converters or with fast-slow coincidence system, spurious counts can arise from pile-up of slow pulses. A method is described for rejection of these pulses. (B.G.D.)

27319 CHARGE-SENSITIVE AMPLIFIER WITH NON-CRITICAL COMPONENTS. Splichal, W. F. Jr. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. Nucl. Instrum. Methods, 41: 156(Apr. 1966). (TID-22287).

A description is given of a charge-sensitive amplifier, which is used to amplify pulses from solid state radiation detectors, which uses unselected NPN 2N697 silicon transistors and requires no critical bias setting. (B.G.D.)

27320 EXAMINATION OF THE VUVET PHOTOMULTIPLIERS TYPE 61 PK 412 (spec.) IN A HIGH FREQUENCY VOLTAGE CONTROL REGIME. Vysocansky, M. (Electrotechnical Institute, Bratislava); Ondris, L.; Nagy, L.; Lehotay, E.; Mukhin, S. V.; Rikhvizki, S. V.; Semenyushkin, I. N.; Raus, I. Nucl. Instrum. Methods, 41: 157-60(Apr. 1966).

An examination of a modified Vuvet photomultiplier tube, having a control grid in the photocathode region is presented. Measurements of the fundamental parameters of the control photomultiplier tube are performed by the method of random coincidences using a h-f voltage on the control grid and a light impulse generator. Coincidence characteristics of the photomultiplier tube were measured with π^- meson beams with a momentum of 5 Bev/c. (B.G.D.)

27321 HIGH-RESOLUTION X-RAY AND ELECTRON SPECTROMETER. Elad, E.; Nakamura, M. (Univ. of California, Berkeley). Nucl. Instrum. Methods, 41: 161-3(Apr. 1966). (UCRL-16515).

A high-resolution spectrometer is described with which resolution of 0.97 kev (fwhm) was obtained for ^{57}Co x rays and 1.5 kev for ^{237}U electrons. The influence of the electron source on the energy resolution is discussed. (B.G.D.)

27322 PROPOSAL FOR AN IMPROVED SIGNAL TO NOISE RATIO OF LARGE GRID IONIZATION CHAMBERS. Roedel, W. (Univ., Heidelberg). Nucl. Instrum. Methods, 41: 169-70(Apr. 1966).

The output voltage of a grid ionization chamber is inversely proportional to the capacitance of the chamber, the input capacitance of the following amplifier included. Thus for a given shot noise level of a voltage sensitive amplifier the signal to shot noise ratio is poorer the greater the capacitance of the chamber. A proposal is presented to diminish electronically the effective chamber capacitance. (B.G.D.)

27323 METHOD TO IMPROVE THE FIGURES OF MERIT OF ELECTRON SPECTROMETERS. Baeverstam, U.; Johansson, A.; Gerholm, T. R. (Univ. of Stockholm). Nucl. Instrum. Methods, 41: 171-2(Apr. 1966).

A simple method is presented to obtain a substantial improvement of the transmission of electron spectrometers without significant reduction of the corresponding resolving power. (B.G.D.)

27324 THE PROBLEM OF OPTIMUM SIGNAL TO NOISE RATIO IN AMPLITUDE MEASUREMENTS. Bertolaccini, M.; Bussolati, C.; Gatti, E. (Istituto di Fisica dei Politecnico, Milan). Nucl. Instrum. Methods, 41: 173(Apr. 1966).

The electronic filter which was synthesized by Baldwin and Frantzen (Advances in Electronics and Electron Physics, 3, 225 (Academic Press, New York, 1956)) for extracting amplitude information from pulses delivered by nuclear radiation detectors is demonstrated to be an optimum filter with regards to signal to noise ratio. (B.G.D.)

27325 CORRECTION OF RATEMETER RESPONSE WITH VARYING INPUT AT CHANGES OF READING SCALE. Pilgrim, D. H. (Univ. of New South Wales, Australia). Nucl. Instrum. Methods, 41: 174-6(Apr. 1966).

The distortion arising between the input of a radiation ratemeter and the recorded output due to the response time of the RC circuit is related to transients produced from changes in reading scales of the ratemeter. The corrections for valid output data from linear ratemeters, with constant and varying inputs are discussed for cases in which changes in reading scales are necessary. (B.G.D.)

27326 INTEGRAL TRANSFORM METHODS FOR ANALYSIS OF DELAYED COINCIDENCE EXPERIMENTS.

Sparrman, P. (Uppsala Univ.). Nucl. Instrum. Methods, 41: 177-80(Apr. 1966).

An integral transformed method which has some properties superior to other methods in the analysis of delayed coincidence experiments is described. Two advantages of this method are that instrumental shifts can be corrected for and that consistency checks can be easily performed. The statistical error in this method is of the same magnitude as that of the centroid shift method (for comparatively large decay constants up to 15% improvement is obtained). (B.G.D.)

27327 CADMIUM CORRECTION FACTORS FOR IODINE, INDIUM, AND GOLD FOILS. Powell, J. E.; Beck, C. L. (Texas A and M Univ., College Station). Nucl. Sci. Eng., 25: 204-6(1966).

A method developed by Powel and Walker (Nul. Sci. Eng., 20: 476 (1964)) is applied for determining the cadmium correction factor F_{Cd} for various thicknesses of gold foils and for matching foils developed by Randall and Walker using iodine and indium as activants. The average value of F_{Cd} for the six 40-mil cadmium-covered gold foils was found to be 1.045 ± 0.010, which indicates no variation with foil thickness. For the iodine the indium foils, the values of F_{Cd} obtained were 1.037 ± 0.020 and 1.022 ± 0.020, respectively. (L.B.S.)

27328 IMPROVED DETECTORS AND CIRCUITS SPUR NUCLEAR-PARTICLE RESEARCH. Glos, Margaret Beach. Nucleonics, 24: No. 5, 44-51(May 1966).

A review is given of developments in semiconductor and scintillation detector systems for use in nuclear particle research. (L.B.S.)

27329 DESIGNING SEMICONDUCTOR SYSTEMS FOR OPTIMUM PERFORMANCE. Heath, R. L.; Black, W. W.; Cline, J. E. (National Reactor Testing Station, Idaho Falls, Idaho). Nucleonics, 24: No. 5, 52-6(May 1966).

The elements of a laboratory pulse-height-system using lithium-drifted germanium detectors coupled with 4096-channel ADC systems are examined to determine the limits imposed by present state-of-the-art equipment on the resolution that can be obtained in photon spectrometry. The influence of each component on the measured line width is reviewed. (L.B.S.)

27330 EFFECT OF ENVIRONMENTAL SCATTER ON FILM BADGE READINGS. Paic, Valerija; Rubcic, Antun (Univ., Zagreb). Phys. Med. Biol., 11: 239-43(1966).

Film badges, which had portions filtered both sides by Al, Sn, and Cd filters, as well as an unfiltered portion, were exposed around isolated γ sources (^{226}Ra, ^{60}Co, and ^{137}Cs). The effect of a large unit-density plastic sheet at various distances beneath the films was investigated. Increased blackening representing apparent increased γ dose of up to 40% occurred mainly on the unfiltered portion of the film, due to lower-energy scattered radiation and to secondary electrons from the sheet when it was closer than about 15 cm to the films. Increased blackening when body phantoms were placed immediately behind the films was small, but not negligible. (auth)

27331 DIRECTIONAL DEPENDENCE OF EXPOSURE MEASUREMENTS OF GAMMA RAYS BY FILM BADGES. Paic, Valerija; Paic, Mladen; Rubcic, Antun. Phys. Med. Biol., 11: 244-54(1966).

The angular dependence of the photographic response of a film badge, consisting of Ilford PM1 film in combination with 1 mm thick filters of Al, Cd, and Sn, exposed to ^{60}Co, ^{226}Ra, or ^{137}Cs gamma rays, were studied in detail. Photographic densities as functions of angles of incidence are examined for bare films and paper-wrapped films with filters in front of, behind and on both sides of the film. The results are presented and an attempt made to explain them. The photographic densities of the parts of the paper-wrapped films covered by filters on both sides were found to be practically angular independent, irrespective of the radiations used. (auth)

27332 FURTHER EXAMINATION OF THEORIES RELATING THE ABSORPTION OF GAMMA-RAY ENERGY IN A MEDIUM TO THE IONIZATION PRODUCED IN A CAVITY. Burlin, T. E. (Polytechnic, London). Phys. Med. Biol., 11: 255-66(1966).

Experimental tests of cavity ionization theories previously performed at 1.25 Mev photon energy were extended to energies of 0.66 and 0.41 Mev. The variation of ionization with pressure, with atomic number of the gas, and with the atomic number of the chamber wall agreed more closely with the theory of Spencer and Attix than with that of Gray. Although the measurements in hydrogen at low pressures were probably affected by outgassing from the chamber walls, the predominant cause of the deviation from theory is thought to be the transfer of slow electrons between electrodes. (auth)

27333 STATISTICALLY OPTIMUM RADIATION COUNTING: A CRITICISM OF THE BRADLEY-MARKS BACKGROUND SUPPRESSION TECHNIQUE. Dudley, R. A. (International Atomic Energy Agency, Vienna). Phys. Med. Biol., 11: 313-20(1966).

A general derivation is given of the conditions that should be fulfilled for the attainment of maximum statistical accuracy in radiation counting measurements. Conventional methods of measurement can meet these conditions, whereas the background suppression technique of Bradley and Marks cannot. Conventional methods are, therefore, preferred. (auth)

27334 GAMMA SPECTROMETER WITH A p-i-n SEMICONDUCTOR DETECTOR. Vasil'ev, V. D.; Gal'perin, L. N.; Il'yasov, A. Z.; Lemberg, I. Kh.; Udralov, Yu. I. (Inst. of Physics and Tech., Leningrad). Prib. Tekh. Eksp., No. 6, 58-64(Nov.-Dec. 1965). (In Russian).

A gamma spectrometer with a p-i-n germanium detector cooled to the temperature of liquid nitrogen is described. The γ spectrum is recorded by a 128-channel amplitude analyzer with an expander at the input. Line width of instrument noise is kept to 5 kev by a low-noise Chase preamplifier and carefully designed shielding. A block diagram of the unit is shown. The detector is housed in the vacuum chamber of a Dewar flask and is kept at a temperature close to –190°C by good thermal contact with the bottom of a vessel filled with liquid nitrogen. The signals to be studied are fed to the preamplifier and mixed at the input with reference pulses from the amplitude-controlled oscillator. The oscillator also generates code pulses in synchronization with the reference pulses which are fed through an hf cable to the input of the amplitude analyzer. The code pulses separate the reference pulses from the detector signals after amplification. These same code pulses prevent registration of the reference pulses when the detector signals are being recorded. Pulses from a second amplitude-controlled oscillator may also be fed to the preamplifier input for simulating detector signals when checking the operation of the device. From the output of the preamplifier, the signals being studied and the reference pulses are fed to the third grid of a 6A3P tube, which controls amplification during stabilization. Amplification control voltage from the stabilization unit is fed to the first grid of this tube. The signals are then amplified by a UIS-II amplifier and fed through the expander to the amplitude analyzer. The various sections of the unit are described in detail, with diagrams of the cooling unit, low-noise pre-amplifier, expander, stabilization circuit, and output stage of the amplitude-controlled oscillator. Tests showed that continuous-duty stability of the analyzer is better than 0.15% with no apparent effects of interference from the cyclotron with which it is designed to be used. (ATD)

27335 ANTICOINCIDENCE GAMMA-RAY SCINTILLATION SPECTROMETER. Broder, D. L.; Panarin, M. V.; Utyuzhnikov, A. N.; Kham'yanov, L. P. Prib. Tekh. Eksp., No. 6, 67-70(Nov.-Dec. 1965). (In Russian).

A total absorption gamma spectrometer is described. It was equipped with a 50 × 100 mm NaI(Tl) anticoincidence crystal. The central crystal measured with ^{137}Cs had a 10% energy resolution at 662 kev. The gamma spectra from ^{65}Zn, ^{24}Na, and Po + Be sources were measured. The measurements also included the gamma spectrum originated in a ^{149}Sm sample by the (n,γ) reaction. The spectra were graphically illustrated for the circuits with and with-

out anticoincidence pulses. The spectral line shapes obtained with one-crystal spectrometer were compared with the lines obtained from the anticoincidence spectrometer equipped with the same NaI(Tl) crystals. The spectrometer was designed for measuring spectra of gamma rays resulting from resonance capture of neutrons. The usefulness of this spectrometer for analysis of complex spectra at high efficiency was demonstrated. A schematic outline of the spectrometer arrangement and an electronic circuit diagram are included. (ATD)

27336 SLOW ION COUNTER. Kozlov, V. F.; Kolot, V. Ya.; Dovbnya, A. N. (Physicotechnical Inst., Kharkov). Prib. Tekh. Eksp., No. 6, 81-3(Nov.-Dec. 1965). (In Russian).

A scintillation counter is described in which slow positive and negative ions accelerated up to energies of several kev fall on the first dynode of the secondary-electron multiplier. This arrangement is similar to that described previously. However, the single ion-electron stage was replaced by a multistage FEU-38 dynode system with nonactivated dynodes. The electron beam from the secondary-electron multiplier, accelerated up to several kev, enters the scintillator. The scintillation flashes are recorded by a photomultiplier. A high pulse amplitude (enhanced by multistage cascades) completely discriminates dark pulses originated in the photomultiplier. By using nonactivated dynodes with low gain, it became possible to reduce the number of dark pulses to about one pulse per 10 sec. Such a low number permits investigation of ion beams of very low intensity. The FEU-38 photomultiplier was equipped with CsI crystals. The output pulses were recorded by a PS-10000 counter. The voltage was applied from a VS-22 rectifier. The circuit arrangement is shown schematically. The dependence of number of pulses upon the voltage in the accelerating gap was plotted for various gain values. Experimental curves demonstrated that the amplitude of ion pulses was much higher than the amplitude of noise pulses. The counting efficiency was the greatest for energies exceeding 4 kev. (ATD)

27337 USE OF A HIGH-SPEED COINCIDENCE CIRCUIT FOR SLOW PULSES IN A NEUTRON DETECTOR. Rdoionov, K. G.; Wang, Nai Yen; Khen Een gyn'; Yao, Ch'i Ch'uan (Joint Inst. of Nuclear Research, Dubna, USSR). Prib. Tekh. Eksp., No. 6, 93-7(Nov.-Dec. 1965). (In Russian).

A coincidence circuit with a theoretical resolving time of $1.5(10)^{-10}$ sec for use in a detector for measuring the total effective cross section of interaction between neutrons and nuclei by the gating method is described. The operating principle of the circuit is as follows: If pulses with a steep front are fed to the input of the shaper in the coincidence circuit, the triggering moment of the device at any threshold depends on the height of these pulses. Even when the sensitivity of the circuit is high, the time scatter lies within the limits of the pulse front. Thus the resolving time of the circuit for 100% efficiency has a direct relation to the rise time of the pulse. This time scatter may be compensated if a shaper circuit is used with a triggering threshold which varies in proportion to the input amplitude. Block and schematic diagrams are given for a circuit with this type of compensation. Tests with 3.5- and 1-meter shaper cables in the pickup unit of the neutron detector gave resolving times $2\tau = 57$ nanosec and 29 nanosec, respectively. Curves are given showing the amplitude spectra of thermal neutrons. (ATD)

27338 FAST COINCIDENCE CIRCUIT WITH DISCRIMINATION OF RANDOM COINCIDENCES. Belogurov, V. N.; Vasil'ev, V. F. (Inst. of Physics, Riga). Prib. Tekh. Eksp., No. 6, 195-7(Nov.-Dec. 1965). (In Russian).

A circuit is described for simultaneous measurement of true and delayed random coincidences. Slow scintillators with NaI(Tl) crystals were used. The circuit is based on the utilization of backlash characteristic of a Schmidt trigger and is similar to the circuits described previously. The arrangement used consisted of 14 electron tubes. They were divided into six main circuits including the delayed and nondelayed pulse shaping circuit, the coincidence circuit, the nondelayed pulse forming circuit, the random-coincidence discrimination circuit, the amplification circuit, and the anticoincidence circuit. The resolving time, measured by an FEU-13 photomultiplier, was 30 nsec. A 100% selection was obtained for bipolar input signals having amplitudes from 5 to 90 v and a front build-up time of 0.3 μsec. The arrangement was illustrated by a block diagram and connection network. (ATD)

27339 BLOCKING OF VOLTAGE SOURCES SUPPLYING GEIGER-MUELLER COUNTERS. Solov'ev, K. I. (Moscow State Univ.). Prib. Tekh. Eksp., No. 6, 197-8 (Nov.-Dec. 1965). (In Russian).

An automatic electronic system controlling the power sources of Geiger counters is described. This system was successfully used during a period of three years in connection with hodoscope measurements of cosmic rays. Geiger counters of the SI-5G type were employed. Voltage regulation was in the limits of ±3%. Due to a high counter background (about 15 pulses per second) and proper adjustments of resistors and capacitors, the counter operation was not affected by background fluctuations. The sensitivity and response time could be adjusted by a time relay. The response time did not exceed one second at voltage rise nor ten seconds at voltage drop. The circuit was composed of a special blocking counter, one-stage amplifier, cathode followers, diodes, and other elements. The operation of the circuit was briefly explained, and a circuit diagram was presented. (ATD)

27340 DETECTION OF HIGH-ENERGY PHOTONS AND ELECTRONS. Heusch, Clemens A. (California Inst. of Tech., Pasadena). Contract AT(11-1)-68. pp 408-17 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

Several types of counting devices are described and compared. Some applications of these devices to experiments are briefly discussed, and a method of increasing the geometrical resolution by using crossed hodoscopes is described. (G.O.Y.)

27341 TOTAL ABSORPTION GAMMA-RAY HODOSCOPE. Lewis, R.; Luckey, D.; Uglum, J. (Massachusetts Inst. of Tech., Cambridge). pp 424-6 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

A total-absorption Cherenkov-counter hodoscope, which was developed to detect particles that decay predominantly into gamma rays, is described. The performance of the hodoscope in an experiment on the photoproduction of mesons (π^0) is discussed. (G.O.Y.)

27342 SPECTROMETERS FOR HIGH ENERGY ELECTRONS. Wapstra, A. H.; Burger, J. J.; Scheepmaker, A.; Swanenburg, B. N.; Tanaka, Y. (Lab. for Technical Physics, Delft, Netherlands). pp 450-5 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

Two types of energy spectrometers were investigated for use in the measurement of the spectrum of cosmic electrons in an artificial satellite. One was a sandwich type consisting of circular layers of lead plates and well-polished plastic-scintillator plates; the other type used total-absorption Cherenkov counters. (G.O.Y.)

27343 DETECTION OF LOW-ENERGY β RAYS USING LIQUID SCINTILLATOR COUNTERS. Laustriat, Gilbert (Centre de Recherches Nucleaires, Strasbourg). Rev. Med. Toulouse, 1: 147-62(Feb. 1965). (In French).

The efficiency and simplicity of using liquid scintillators for measuring the low-energy beta rays emitted by ^{14}C, ^{35}S, and T are pointed out. Basic characteristics of liquid scintillators are discussed, including the scintillation mechanism and the effects of dissolved molecular oxygen, water, internal absorption, and parasitic luminescence on the scintillation output. Methods for preparing the scintil-

lating solution—dissolving, suspending, or oxidizing and dissolving the labeled material in the scintillator—are described. Determination of the detection efficiency using the methods of the internal standard and of comparison of two channels and improvement of the efficiency are considered. Detection of a mixture of beta emitters is discussed. Detection of samples fixed on paper or on a thin-layer chromatogram is described. (M.J.T.)

27344 PHASED ROTATING CRYSTAL AND CHOPPER FOR TIME-OF-FLIGHT NEUTRON SPECTROSCOPY. Harling, O. K. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. Rev. Sci. Instrum., 37: 697-709(June 1966). (BNWL-SA-302).

A slow neutron spectrometer that uses a rotating single crystal to chop and monochromate the reactor neutron beam is described. A high transmission mechanical chopper is operated in phase with the rotating crystal to eliminate undesired crystal reflections and higher order contamination, and to suppress the background of time uncorrelated neutrons. Pulsed neutron beams of high quality can be obtained from the thermal energy range to greater than 0.5 ev. Energy widths as low as 1% with burst widths around 7 μsec can be attained at 0.3 ev. Intensities are adequate for inelastic scattering studies. The spectrometer is designed primarily for downscattering measurements. Scattering measurements are conducted in a completely shielded scattering chamber with eleven scattered neutron detectors arranged at scattering angles of 15 to 165°. Time-of-flight techniques are used to determine the scattered neutron spectra. The design, construction, and performance characteristics are given. Some representative measurements made on zirconium hydride are presented. (auth)

27345 RESOLVING TIME DETERMINATION OF NUCLEONIC APPARATUS WITH THE TWO-SOURCE METHOD. Marais, P. G. (Fruit and Food Tech. Research Inst., Stellenbosch, South Africa). S. Afr. J. Agr. Sci., 8: 969-78(1965).

A comparison is made of the various formulas that were proposed for the two-source method to determine the resolving time of nucleonic apparatus, and it is demonstrated that widely different and even incorrect values can be obtained. The best procedure is to use sources with similar activities since this ensures maximum accuracy and leads to a simple formula. Results are presented to prove that under conditions where scalers, external quenching probes, and G-M counters are the limiting factors determining the resolving time, the latter is independent of the counting rate. It is concluded that the resolving time of nucleonic apparatus normally in use by agricultural research workers may be considered nonextendable up to counting losses of at least 20%. The results also demonstrate that resolving time can be determined to an accuracy of a few per cent, and even better, by the simple two-source method. The resolving time for a particular instrument remains constant for prolonged periods and only occasional tests are required unless components are replaced. An important finding is that values quoted by manufacturers cannot always be accepted and that similar types of equipment have widely different resolving-time values. (BBB)

27346 SOME PROBLEMS AND PERSPECTIVES IN COSMIC-RAY STUDIES. Grigorov, N. L.; Rapoport, I. D.; Savenko, I. A.; Skuridin, G. A. (Academy of Sciences, Moscow). Space Sci. Rev., 5: 167-209(Mar. 1966).

The principles of an ionization calorimeter, an instrument used to measure the energy of cosmic-ray particles and the dependence of its parameters on the conditions of operation, are discussed. Possible applications of this calorimeter in the study of nuclear interactions of 10^{11}–10^{13} ev cosmic-ray particles, study of the composition of high-energy primary cosmic rays (10^{11}–10^{14} ev), and investigation of the electron component of cosmic-ray primaries and high-energy γ rays are reviewed. (auth)

27347 MEASUREMENT OF MOMENTA OF FAST CHARGED PARTICLES (10^{10} to 10^{12} ev/c) BY THE SPARK CHAMBER-PHOTOEMULSION TECHNIQUE. Daion, M. I.; Eliseev, V. B.; Kazaryan, M. A. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz., 50: 376-8(Feb. 1966). (In Russian).

Experimental data are presented on the probability of detecting the tracks of charged particles in a photoemulsion (thickness 200 μ) as indicated by a spark chamber telescope. (auth)

27348 CALORIMETRIC MEASUREMENTS OF ENERGY CURRENT AND ABSORPTION OF ^{60}Co γ RAYS. Rassow, B. Berlin, Freie Univ., 1965. 40p. $2.00 Gmelin, AED-Diss. 65-250.

Construction of a differential calorimeter is described. Absorption of ^{60}Co γ rays in Pb, Hg, and water is investigated. Results are in agreement with previous data. (Gmelin Inst.)

27349 LINEAR-LOGARITHMIC RADIATION MONITOR /Q-2232/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1284).

4 drawings.

The linear logarithmic, G-M tube radiation device with normal operation at low gamma dose rates was designed to monitor the secondary cooling system of the Oak Ridge Research Reactor. The sensing unit is capable of operating outdoors with varying temperature and humidity and of driving as much as 500 ft of cable. The linear output signal covers the range from 0 to 10 mr/hr and actuates a transistorized high and low off-normal monitor. The logarithmic output actuates a recorder to record 10 mr/hr to 100 r/hr. The sensing unit consists of 2 G-M tubes, a trigger tube, and two corona regulator tubes. The regulator tubes permit the sensing unit to be operated from one regulated, negative 900-v h-v supply. (J.F.P.)

27350 CUTIE PIE SURVEY METER, MARK 5 /Q-2299/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1333).

11 drawings.

The survey meter employs an ionization chamber. The Al case to which the ionization chamber is attached is 4¼ in. × 5 in. × 3 in. A pistol grip-type handle is attached to the case. A Simpson meter, Model 1227, reading in m/rad/hr is used and four batteries of 22½ v are needed. A tube tester, included with the package, tests for grid voltage, current, and power. (For details, see TID-4100.) (J.F.P.)

27351 PREAMPLIFIER FOR 3/4 IN. FISSION CHAMBER /Q-2263/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1303).

7 drawings.

This preamplifier, used with the ¾ in. fission chamber, withstands operating temperatures of 125°C and an accumulated γ dosage of 10^8 r. The miniaturized fission chamber was designed for high flux reactor usage. The preamplifier is 12-in. long and because of its small size, potting is used to hold the components and to improve heat transfer. The separation between the chamber and the preamplifier should be as small as possible to reduce noise pickup and to insure the use of the required single-point ground. The minimum separation lengths, as dictated by the permissible radiation dosage to the preamplifier in a year of continuous use, are 4 to 5 ft. The range of the system is to extend to 10^5 counts/sec, with a counting loss not greater than 10%. (For details, see TID-4100.) (J.F.P.)

27352 SILICON DIODE NEUTRON SPECTROMETER /Q-2262/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1302).

3 drawings.

A remotely operated neutron spectrometer is used under water to measure the neutron flux in swimming pool reactors. Two radiators (^{6}Li and ^{7}Li) mounted side by side on an Al radiation wheel can be remotely positioned between 2 silicon diodes in obtaining neutron flux spectra. The equipment is housed in Al tubing 12 in. long, 4 in. OD, and 3¾ in. ID. An Al frame in the housing is 11$^{13}/_{64}$ in. long with a 3½ in. OD and a 3¼ in. ID. (For details, see TID-4100). (F.L.S.)

27353 GAMMA SCINTILLATION DETECTOR 4 x 4 CRYSTAL /Q-2255/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE–1299).

1 drawing.

The detector consists of a large NaI crystal 4 in. in dia and 4 in. long contained in an evacuated 1100F Al tube 4.5 in. long and 4.310 in. OD. The can has a cap of 1100F Al foil or sheet, and is lined with MgO. The photomultiplier is a CBS CL-1083. Black electrical tape $^3/_4$ in. wide covers the entire glass surface of the tube. The detector is used in γ-ray spectroscopy. (For details, see TID-4100). (F.L.S.)

27354 STEP-SCAN PROGRAMMER /Q-2269/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE–1306).

3 drawings.

This programmer is used in reading the output of the Dual 12 In. Mass Spectrometer. The device automatically steps the voltage across the mass spectrometer to aid in finding the specific elements that are being sought. The voltage is set and then the device will scan 10 channels of higher potential, and record the output for each step. (For details see TID-4100). (J.F.P.)

27355 DOSIMETER. Bryer, Robert Georg (to R. A. Stephan and Co., Ltd.). German Patent 1,208,013. Dec. 30, 1965. Priority date May 21, 1962, Great Britain.

The radiation sensitive element of the dosimeter (a glass block containing dissociating phosphate material) is enclosed by a twofold inner housing the parting face of which is provided with a sealing ring. The said inner housing is surrounded and pressed together by a twofold outer housing the two parts of which are screwed together. (Gmelin Inst.)

27356 CIRCUIT ARRANGEMENT FOR THE DETECTION OF ENERGETIC RADIATION. Seiler, Karl Otto; Keller, Hans (to Intermetall Gesellschaft fuer Metallurgie und Elektronik mbH). German Patent 1,208,419. Jan. 5, 1966. Filed Nov. 15, 1961.

The circuit arrangement for the detection of nuclear radiation comprises a counter tube, an indicating means connected to the counter tube and provided with a storage condenser which supplies the electric power for the counter tube and the indicating means, and a piezoelectric transformer which charges the storage condenser via a rectifier. A limiter diode is switched in parallel to the piezoelectric transformer which limits the condenser charge of a given polarity and prevents the voltage of opposite polarity from surpassing the inverse voltage of the rectifier. (Gmelin Inst.)

27357 ACTIVATION NEUTRON DETECTORS AS WELL AS METHOD FOR THEIR FABRICATION. Linguet, Roger; Rodier, Georges; Roger, Joel; Sagot, Marcel (Commissariat a l'Energie Atomique). German Patent 1,208,829. Jan. 13, 1966. Priority date Dec. 15, 1961, France.

The radioactive activator is composed of a mixture of dysprosium and a metal or a metal oxide. The detector comprises a metallic base plate having on one face a layer of the sensitive mixture. The base plate consists of the same metal or metal oxide which is in the mixture. (Gmelin Inst.)

27358 METHOD FOR THE FABRICATION OF HALOGEN GEIGER-MULLER COUNTER. Marx, Georg (to Telefunken Patentverwertungsgesellschaft mbH). German Patent 1,209,668. Jan. 27, 1966. Filed Mar. 26, 1963.

The method comprises the steps of filling the tube with halogen gas at a pressure of about 20 torr and a temperature between 150 and 250°C, of maintaining these conditions for about 30 minutes, of evacuating the tube until a residual vapor pressure of 0.1 torr is attained, and of filling the tube with the predetermined counter gas. (Gmelin Inst.)

27359 ARRANGEMENT FOR CHANGING THE SENSITIVE VOLUME OF A GAS-FLOW BELL COUNTER. Pertermann, Wolfgang (to VEB Vakutronik Dresden). German Patent 1,209,669. Jan. 27, 1966. Filed July 10, 1964.

The bell counter comprises an anode filament loop in the center of the counter chamber, and cylindrical cathode inserts of variable diameter fitting into the counter chamber and into each other, which are successively inserted with diminishing size of the object to be measured, this object being located at the bottom of the chamber. (Gmelin Inst.)

27360 WINDOWLESS COUNTER TUBE FOR THE DETERMINATION OF RADIOACTIVE SUBSTANCES. Wegner, Lutz-Axel (to Farbenfabriken Bayer Aktiengesellschaft). German Patent 1,212,646. Mar. 17, 1966. Filed Mar. 7, 1964.

The radiation entrance opening of the counter tube is provided with an electrode-system which generates an electric field in the vicinity of the opening to prevent secondary charge carriers from outside the counter housing from entering the sensitive volume. (Gmelin Inst.)

27361 EQUIPMENT FOR THE DETECTION OF FISSION PRODUCTS. Dosch, Peter; Jacobi, Siegfried (to Gesellschaft fuer Kernforschung mbH). German Patent 1,213,063. Mar. 24, 1966. Filed Feb. 21, 1964.

The gas containing the fission products to be monitored is passed through a precipitation chamber in which the solid daughter nuclides of the fission products are attracted to a negatively charged electrode. The sensitive volume of a detector disposed within the precipitation chamber is surrounded partially by the precipitation electrode. (Gmelin Inst.)

27362 CALORIMETER CAPABLE OF SEPARATELY DETERMINING NEUTRON ENERGY ABSORPTION AND GAMMA ENERGY ABSORPTION. Lewis, William B. (to U. S. Atomic Energy Commission). U. S. Patent 3,246,153. Apr. 12, 1966.

A description is given of a calorimetric device for differentiating between the gamma and neutron effects in a combined radiation field, comprising three bodies of identical outer dimension arranged symmetrically with respect to each other, a common heat sink for said bodies arranged symmetrically therewith, three identical means for conducting heat from said three bodies to said heat sink, the first and second of said bodies being formed wholly of a first material having a substantially zero characteristic power absorption per unit mass for neutron radiation, the third of said bodies being formed of said first material and a second material having a substantial characteristic power absorption per unit mass for neutron irradiation and a characteristic power absorption per unit mass for gamma radiation substantially equal to that of said first material, each of said bodies differing from the other in total mass, three individual electric means for introducing electric power into said respective bodies, means for individually measuring the electric power, means for indicating a temperature difference between said bodies, and means for individually adjusting the electric power until the temperatures of the three bodies are equal. (AEC)

Radiation Effects

27363 (AD–632112) SURFACE EFFECTS OF RADIATION ON MICROELECTRONIC DEVICES. Final Report of Part I. Binder, D.; Kuehne, B. M.; Wilbur, R. I.; Butcher, D. T. (Hughes Aircraft Co., Fullerton, Calif.). Nov. 2, 1965. Contract N228(62479)68466. 67p. (USNRDL-TRC–19; FR–65-10-243). CFSTI $3.00 cy, $0.75 mn.

Measurements of I_{CBO} and h_{FE} were made on conventional planar transistors, both as individual components (2N708 and 2N1132) and as parts of a simple integrated circuit with two transistors (Signetics C5018K). The measurements of I_{CBO} of the individual transistors after Linac irradiation showed short-lived surface effects as well as the semipermanent effects observed in the cobalt source. The long decay constants of I_{CBO} in the 2N708 transistors indicated the presence of slow states excited by the radiation pulse in the oxide layer. Although these effects were not observable in the cobalt source, the long term surface effects on I_{CBO} were roughly equivalent for

the two sources. Changes in h_{FE} were small for all exposures (to ~10^6 rads). The integrated circuit chosen for study was the transistor pair. The irradiations often showed the effect of substrate leakage. A much rarer phenomenon was an interaction between effects on the two transistors. Measurements of drain current and transconductance made on thin film transistors showed both intermediate and long term surface effects. These were found to depend upon the particular initial surface properties of the unit, as well as upon the applied bias during irradiation. Semipermanent effects for the TFT's could be explained as the result of radiation-induced changes in the charge concentration of the conducting channel, and do not appear to be simple decays from intermediate effects. The results for both conventional planar transistors and transistor pairs were examined to determine the effect of component vulnerability on circuits. (auth)

27364 (NASA-TN-D-3427) A COMPARISON OF SOLAR CELL DAMAGE BY ALPHA PARTICLES AND PROTONS. Smith, Albert B.; Blue, James W. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). May 1966. 14p. CFSTI $1.00 cy, $0.50 mn.

The short circuit current of silicon solar cells illuminated with 2800°K light was measured after the cells received successive increments of proton or alpha particle bombardment. The incident particle energies were 10.5 and 42 Mev respectively, and therefore have identical velocity distributions and ranges in the solar cell. The ratio of the proton flux to the alpha particle flux to produce the same degradation in short circuit current is 3.8. For particles of equal velocity, the ratio of the Coulomb cross section for alpha particles to that of protons to produce silicon recoils of equal energy is 4. If the experimental uncertainties are considered, the experimental result is in agreement with this ratio, and this agreement implies that the relatively few high energy recoils from close alpha particle collisions do not contribute significantly to the cell degradation. (auth)

27365 (SC-DC-3127A) PULSED RADIATION SOURCES FOR STUDIES OF RADIATION EFFECTS IN ELECTRONICS. Snyder, A. W. (Sandia Corp., Albuquerque, N. Mex.). [nd]. Contract AT(29-1)-789. 6p. ORAU.

The most significant characteristics of pulsed reactors, linear accelerators, and flash x-ray generators for use as radiation sources for radiation effects studies on electronics are outlined. (M.O.W.)

27366 BEHAVIOR AND UTILIZATION CRITERIA OF TRANSISTORS UNDER NUCLEAR IRRADIATION. Pigneret, J.; Genre, R.; Glotin, PH.; Samueli, J. J.; Sarazin, A. (Centre d'Etudes Nucleaires de Grenoble, France). Nucl. Instrum. Methods, 41: 226-40(1966). (In French).

The experimental study of the radiation damage on the electric properties of silicon planar transistors is described. An attempt is made to have a general view to the problem and specially to give valuable information about the optimum conditions of the choice and the utilization of the device to the circuit designer. A wide variety of radiation sources was used in order to check the validity of the equivalence between particles and energies. The degradation rate of d-c and a-c gain was studied as a function of the injection level and the bias conditions under radiation. The behavior at very low currents, the variations in high frequency and commutation parameters, the thermal recovery and the dose rate influence are also described. (auth)

27367 EFFECTS OF ELECTRON IRRADIATION OF METAL-NITRIDE-SEMICONDUCTOR INSULATED GATE FIELD-EFFECT TRANSISTORS. Stanley, A. G. (Massachusetts Inst. of Tech., Lexington); Wegener, H. A. R. Proc. IEEE (Inst. Elec. Electron. Eng.), 54: 784-5(May 1966).

From previous investigations, metal-oxide-semiconductor devices have been shown to be highly susceptible to electron irradiation. It is shown that the substitution of silicon nitride for silicon oxide as the insulating layer in these devices greatly reduces the shift in gate turn-on voltage and practically eliminates the leakage currents in p-channel devices which were the adverse effects in MOS devices. (B.G.D.)

27368 LOW-ENERGY PROTON DAMAGE IN PARTIALLY SHIELDED SOLAR CELLS. Brucker, G. J. (RCA Labs., Princeton, N. J.); Dennehy, W.; Holmes-Siedle, A. G.; Loferski, J. J. Proc. IEEE (Inst. Elec. Electron. Eng.), 54: 798-9(May 1966).

An experiment is described to determine the damage to partially shielded solar cells from 200-kev protons. The solar cells had exposed areas between 1 to 100% and the normalized short-circuit current, open-circuit voltage, and maximum power as a function of proton fluence were measured. (B.G.D.)

ISOTOPE TECHNOLOGY

General

27369 LOW-ENERGY X AND GAMMA SOURCES AND APPLICATIONS. Lafferty, Robert H. Jr. Isotop. Radiat. Technol., 3: 88-102; 110-11(Winter 1965–1966).

The Symposium on Low-Energy X and Gamma Sources and Applications held at Illinois Institute of Technology Research Institute on Oct. 21 and 22, 1964, is summarized. Papers were given there on preparation and evaluation of low-energy x and gamma sources and on the use of such sources for chemical analysis by x-ray fluorescence and absorption, industrial gaging, industrial radiography, and medical radiography, bone analysis, and organ visualization. See ORNL-11C-5 for complete proceedings. (auth)

Industrial Applications

Refer also to abstract 26926.

27370 (AD–632360) CALCULATED INTERNAL RADIATION DOSE FROM INGESTION OF MEAT STERILIZED BY ELECTRON IRRADIATION. Martin III, Thomas G. (Army Natick Labs., Mass.). Apr. 1966. 28p. CFSTI $2.00 cy, $0.50 mn.

The production of radionuclides in food irradiated with high energy electrons can be predicted reasonably well with an equation that is presented. Using this equation and others it was possible to estimate the amount of radiation received by humans consuming beef irradiated by high energy electrons. The estimated annual internal doses decrease with storage time. At the maximum energy treated the dose would decrease from a maximum of 2.36 mrem/yr to a minimum of 0.113 mrem/yr with a storage time of 7 days and two years, respectively. The calculated values represented approximately 0.1 to 2% of the average mean radiation exposure of humans, 130 mrem/yr due to natural environmental radiation. (auth)

27371 (BNL–10174) A REVIEW OF THE ^{60}Co SOURCE DEVELOPMENT PROGRAM AT BROOKHAVEN NATIONAL LABORATORY. Kuhl, O. A. (Brookhaven National Lab., Upton, N. Y.). Apr. 22, 1966. Contract AT(30-2)-Gen-16. 33p. (CONF-660609–1). Dep. mn. CFSTI $2.00 cy, $0.50 mn.

From International Symposium on Food Irradiation Meeting, Karlsruhe, Ger.

Developments in ^{60}Co radiation sources and dosimeters at Brookhaven are described. Tubular and flat ^{60}Co sources are described, and special attention is given to the Mark I and Mark II standard cobalt sources. The advantages and economics of these sources are discussed. Other dosimeters are also mentioned briefly. Several illustrations of ^{60}Co radiation sources are included. (P.C.H.)

27372 ORGANOLEPTIC QUALITY OF CAKE AND BREAD MADE FROM ^{60}Co-IRRADIATED FLOUR AND FLOUR FROM IRRADIATED WHEAT. Miller, Byron S.; Yamahiro, Roy S.; Trimbo, Henry B.; Luke, Kenneth W. (General Mills, Inc., Minneapolis). Cereal Sci. Today, 10: 80-2(Mar. 1965).

Portions of wheat were irradiated before milling, and other portions were milled into flour before irradiation. Irradiation of both wheat and flour was accomplished in glass jars using a ^{60}Co source at dose levels of 10,000, 20,000, 35,000 and 50,000 rad. White cake was made with whole milk and fresh egg whites. Bread was made by a straight-dough procedure. All samples were taste-tested in a specially constructed taste-panel room where lighting and extraneous odors could be controlled. All samples were baked on the day of testing. All subjects were experienced taste-testers but inexperienced in testing irradiated products. In terms of over-all offensiveness (least preferred) the control sample (0 rad) was least offensive, the 20,000-rad sample the most offensive, and the 50,000-rad sample was intermediate in offensiveness. Using samples with and without vanilla, it was found that vanilla does not have a masking effect on the odors and flavors caused by irradiation of flour. A similar study was conducted with bread made from irradiated flour. Again, the 20,000-rad sample was judged to be the most offensive. Regarding cake odor, the 20,000-, 35,000-, and 50,000-rad samples were judged to be significantly worse than the 10,000-rad sample. Differences between the zero- and 10,000-rad samples were not significant. Cake made from flour irradiated with 20,000 to 50,000 rad had a faint musty or moldy odor. The same observations applied to bread made from irradiated flour. Cake made from flour irradiated with 0.1×10^6 or more rad had a definite goaty, caprylic, or "wet-dog" odor. There was no detectable difference that was the result of irradiating wheat rather than flour. It was concluded that the changes that occurred were slight but that they might be sufficient to turn the consumer, if given a choice, to non-irradiated products. (BBB)

27373 CURRENT TRENDS IN RADIOISOTOPE TECHNIQUES. PART II. EuroNuclear, 3: 183-4(Apr. 1966).

In Italy research is being carried out on various aspects of radioisotope applications for the purpose of simplifying and improving services such as gas and water supplies to the general public. In Poland various organizations are active in the field of radioisotope applications. In the field of physics the interest is concentrated on radioisotope research in solid state, macro- and microscopic metals and alloy structures, and on the kinetics of phase transmutation and diffusion. Radiometric techniques and uses of radioisotopes in chemistry and agriculture are also studied. (J.F.P.)

27374 SOME ASPECTS OF FOOD IRRADIATION: A VISUAL PORTFOLIO. Schultz, H. W.; Lee, Jong S. (Oregon State Univ., Corvallis). Food Technol., 20: 44-5(Feb. 1966).

Illustrations and comments are provided relating to techniques and results of investigations of radiation preservation of various foods. Strawberries seem to be the most promising of fruits for radiopasteurization. Shasta strawberries were irradiated with 200,000 rad of γ rays and held 8 days at 41°F. Mold was present on controls but not on irradiated fruit. A mobile γ irradiator for pasteurization of field products, e.g., fruits, is shown, as well as an on-board ship irradiator for pasteurization of marine products at sea. Pilot operation is now underway at Gloucester, Mass., with a marine products development irradiator. The control console of this unit which employs closed circuit television, is illustrated. This instrument panel governs use of the radioactive source of 250,000 C of ^{60}Co in the γ cell behind a massive shielding door which weighs 4½ tons. Also shown is the system by which the radioactive source is raised from the bottom of the shielding pool on the curved track into irradiating position between trays on a conveyor line. Meat irradiation in a pilot operation is also illustrated. Sliced bacon, packed in containers, is stacked in a conveyor rack which moves via an overhead system to the irradiation preservation area at the U. S. Army Natick Laboratories, Natick, Mass. Movement of the containers from the time they leave the loading area until the processing of their contents is tracked on a control panel located in an adjoining chamber. (BBB)

27375 RECENT DEVELOPMENTS IN THE PRODUCTION OF WOOD–PLASTIC COMBINATIONS. Fuccillo, D. A. Isotop. Radiat. Technol., 3: 115-31; 144-6(Winter 1965–1966).

A literature review emphasizing technical aspects of producing wood–plastic combinations (WPC), action of radiations, inhibition and acceleration of polymerization, and physical parameters is presented. These materials can be produced by several methods. Conventional techniques use chemical catalysts to initiate polymerization. Radiation techniques involve monomer impregnation, with

or without prior swelling of the wood, and irradiation. Experiments at West Virginia University, which are reviewed, include determination of optimal conditions for producing WPC, addition of chemicals to speed up polymerization, dose-rate studies, copolymerization, production of colored WPC, and further tests on physical properties of the products. Selected literature on the effects of radiation on wood components and on monomers is also reviewed. (auth)

27376 TECHNICAL AND ECONOMIC CONSIDERATIONS FOR AN IRRADIATED WOOD–PLASTIC MATERIAL. Greene, R. E.; Baker, P. S. Isotop. Radiat. Technol., 3: 131-43; 146(Winter 1965–1966).

An evaluation of the commercial utility of irradiated wood–plastic combinations (WPC) indicated that these materials should find their widest application in products where raw-material cost is small relative to production cost, where the esthetic qualtities of wood are important, or where those enhanced physical properties that the process imparts to wood are of special value. The potential applications include fabricated materials of construction (stair treads, counter tops, and flooring), furniture, sporting goods, and specialty items. The estimated dollar costs for 2500-, 1250-, and 625-lb/hr processing plants are $1,560,000, $1,045,000 and $743,000 for investment capital and $676,000, $478,000, and $391,000 annual operating costs, respectively. Recommendations are made for further establishing the utility of the product. (auth)

27377 ECONOMICS OF WORLDWIDE INDUSTRIAL APPLICATIONS OF RADIOISOTOPES. Gerrard, Martha. Isotop. Radiat. Technol., 3: 152-66(Winter 1965–1966).

A survey conducted by the International Atomic Energy Agency (IAEA) indicated a total annual savings, in 26 countries, of $296 million to $400 million as a result of the industrial use of radioisotopes. Categories of uses were gaging, radiography, ionization, tracing (including activation analysis), massive irradiation, and miscellaneous. Industries were grouped into 12 classes. (auth)

27378 ATTEMPTS AT PASTEURIZING EGG NOODLES BY IRRADIATION WITH γ-RAYS. Jedlicka, Vaclav; Otta, Karel; Matejova, Simona; Linhart, Alois (Ustredni Vyzkumny Ustav Potravinarskeho Prumyslu, Prague. Prazske Pekarny a Mlyny, N. P., Prague). Prumysl Potravin, 15: 528-9(Oct. 1964). (In Czech).

Packaged broad noodles and square noodles were irradiated evenly with doses of 100, 250, and 500 krad from a ^{60}Co source to destroy microörganisms that may have grown in the eggs used in the noodles. Microbiological analysis was performed on irradiated noodles and the total bacteria, coliforms, staphylococci, and molds were counted. Coliforms were eliminated, staphylococci were greatly reduced, but molds remained unaffected. Little or no change was noted in the moisture content and the degree of acidity of the noodles. A panel of 8 persons judged the appearance, consistency, aroma and taste of cooked, irradiated and control noodles. Noodles irradiated with 100 krad were nearly indistinguishable from the controls, but doses of 250 and 500 krad caused undesirable characteristics. (OID)

27378 THE EFFECT OF γ-RADIATION ON THE COURSE OF SUBTERRANEAN GASIFICATION OF COAL. Rauk, Jerzy; Bujok, Jozef (Glownym Inst. Goernictwa, Katowice, Poland). Przegl. Gorniczy, 18: 647-50(Nov. 1962).

During the development of a technique for underground gasification of coal, information was sought on all aspects of the processes occurring in the conversion of coal to gas at high temperatures, including effects exerted by nuclear radiation on this process. Laboratory tests involving the nuclear effect could only be carried out on a small scale; therefore, apparatus had to be devised for controlling the gasification of coal samples under certain temperature and gas flow conditions with and without γ radiation. A 550-C ^{60}Co γ source was used. The first sample, which was not irradiated, contained 14.5% CO_2, 3% CO, 2.2% H_2, 1.2% CH_4, 78.5% N_2, and 0.6% O_2. An irradiated coal sample contained 12.2% CO_2, 4% CO, 3.3% H_2, 1.6% CH_4, 77.3% N_2, and 1.6% O_2. Due to the higher CH, H_2, and CH_4 content, the caloric value of the gas from irradiated coal was 343 cal/cu m as compared to 250 cal/cu m for unirradiated sample, an increase of 36.7%. The reason for this increase in fuel value is not known, but it was surmised that the γ radiation produced a catalytic center in the coal, which led to a separation of unoxidized gases (CH_4 and H_2) or only partly oxidized ones (CO) as compared with the prevalence of completely oxidized CO_2 in nonirradiated coal. (OID)

27380 APPLICATION OF LARGE RADIATION SOURCES IN INDUSTRY. Text of Lectures of an International Congress on the Subject Mentioned Above, Held in Amsterdam on 12th and 13th November, 1964. The Hague, Nederlands Atoomforum, [1965]. 148p. (CONF-641109).

Nine papers are included; individual abstracts were prepared for each. (J.G.B.)

For abstracts of individual papers see: 26926 and 27381–27388.

27381 NATURE OF SOME REACTIONS INDUCED BY HIGH ENERGY RADIATION. Charlesby, A. (Royal Military Coll. of Science, Swindon, Eng.). pp 9-21 of Application of Large Radiation Sources in Industry. The Hague, Nederlands Atoomforum, [1965].

Potential and present uses of high energy radiation for chemical reactions in industry are discussed. The economics of, sources of, and variations in radiation doses necessary to bring about desirable changes in materials are evaluated. Industrial uses in certain areas, such as food sterilization, pest control, and polymerization show promise. The selection of fields of activity in which the unique properties of high energy radiation are fully utilized is the main concern. (J.G.B.)

27382 CHEMICAL SYNTHESIS BY ENERGETIC RADIATION. Henglein, A. (Hahn-Meitner Institut fuer Kernforschung, Berlin). pp 23-40 of Application of Large Radiation Sources in Industry. The Hague, Nederlands Atoomforum, [1965]. (In German).

The industrial uses of ionizing radiation and the radiotechniques for laboratory preparations of chemicals are reviewed. Specific examples of the use of radiation in synthetic reactions based on radioinduced chain reactions, condensation processes, and capture reactions are considered. The sulfoxidation of hydrocarbons, the synthesis of ethyl bromide, the attachment of phosphorus trichloride to olefins, the production of hydrazine from ammonia, the condensation of inorganic chlorides with hydrocarbons, and organic syntheses with white phosphorus are described. (J.S.R.)

27383 POLYMERIZATION INITIATIONS BY RADIATION. Chapiro, A. (CNRS, Paris). pp 41-52 of Application of Large Radiation Sources in Industry. The Hague, Nederlands Atoomforum, [1965]. (In French).

The induction of radical, ionic, and monomer polymerization in the solid state is reviewed with examples given of specific radiation reactions. (J.S.R.)

27384 GRAFT COPOLYMERIZATION. Cramer, W. A. (Reactor Instituut, Delft, Netherlands). pp 53-67 of Application of Large Radiation Sources in Industry. The Hague, Nederlands Atoomforum, [1965].

Various methods used for the radioinduced formation of graft copolymers are described. Several examples of the modification of cellulose, fibrous materials, and rubber, using irradiation techniques, are given. The use of polyfunctional monomers to improve the yield of cross-links in irradiated polymers is mentioned. Economic aspects of the irradiation processes were considered, and it was concluded that radioinduced graft copolymers may be expected to become commercially important in the near future. (J.G.B.)

27385 IRRADIATION OF POLYMERS. Puig, J. R. (CEN, Saclay, France). pp 69-88 of Application of Large Radiation Sources in Industry. The Hague, Nederlands Atoomforum, [1965]. (In French).

The effects of high-energy radiation on polymers with respect to degradation and reticulation and the effects of these processes on the properties of the irradiated material were examined. The treatments already used in-

dustrially, illustrated by that of polyethylene, and those that have a potential application, such as the radiovulcanization of rubbers, are described. The parameters that make it possible to augment the yields of these treatments are reviewed and their effect on the cost of irradiation treatment is discussed. (tr-auth)

27386 RADIATION STERILIZATION. Crawford, C. G. (Johnson's Ethical Plastics Ltd., Slough, Eng.). pp 111-18 of Application of Large Radiation Sources in Industry. The Hague, Nederlands Atoomforum, [1965].

The advantages and disadvantages of radiosterilization are compared with those of sterilization by conventional methods. The design of a plant for sterilization of medical products using a cobalt-60 source of gamma radiation is described. Mechanisms providing for the safety of personnel are emphasized. The economics of gamma radiosterilization are considered. (J.G.B.)

27387 LARGE GAMMA IRRADIATION INSTALLATIONS. Baines, B. D. pp 119-38 of Application of Large Radiation Sources in Industry. The Hague, Nederlands Atoomforum, [1965].

The design and operation of an industrial irradiation plant using a large cobalt-60 source is described. Safety features required by British regulations and the design philosophy employed to make for easy maintenance are detailed along with development of the plant design. Simple modifications may be made in the design to enable the plant to take megacuries of cobalt-60. For large scale production, this plant can be made fully automatic requiring only intermittent supervision. Operating costs are included. (J.G.B.)

27388 FUTURE ASPECTS OF INDUSTRIAL CHEMICAL RADIATION PROCESSES. Houtmann, J. P. W. (Reactor Instituut, Delft, Netherlands). pp 139-48 of Application of Large Radiation Sources in Industry. The Hague, Nederlands Atoomforum, [1965].

Future trends in the use of radioinduced processes by industry are discussed. The radioactivation of various chemicals and materials and their potential uses are explored. It was concluded that for certain types of chemical processes the use of radiation can have distinct technological advantages. It is anticipated that the cost of radiation energy will become more attractive. Transfer of knowledge to conventional industrial circles seems to be difficult and partly hampered by high capital investment necessary for adequate radiation research. Expansion of suitable research institutes for carrying out preliminary laboratory and semi-technical investigations seems advisable. (J.G.B.)

Power Application

See also ENGINEERING — Space Propulsion

27389 ISOTOPIC POWER DATA SHEETS. Rimshaw, S. J. (Oak Ridge National Lab., Tenn.). Isotop. Radiat. Technol., 3: 147-51(Winter 1965–1966).

Nuclear and physical properties of some unclassified radioactive source materials that have potential applications to terrestrial, marine, and aerospace power requirements were compiled from various publications. The radioisotopes considered were ^{60}Co, ^{90}Sr, ^{137}Cs, ^{144}Ce, ^{147}Pm, ^{242}Cm, and ^{244}Cm. Where information was not available, the probable values were derived from data in the literature on inactive or related materials. (auth)

27390 TRANSFORMATION OF ENERGY FROM RADIONUCLIDES INTO ELECTRICAL ENERGY. Scharmann, A. (Univ., Giessen, Ger.). pp 112-14 of Physikertagung 1965 Frankfurt (M)-Hoechst, Okt. 4-9. Vorabdrucke von Kurzfassungen der Fachberichte. Stuttgart, B. G. Teubner Verlagsgesellschaft mbH, 1965. (In German).

Methods are available for the transformation of the energy of radionuclides into electrical energy. These are the direct charging of a collector by α or β particles, photovoltaic installations, contact potential methods, thermoelectric radionuclide batteries, thermonic radionuclide batteries, and photoelectric radionuclide batteries. The limits of these methods and the technical future are discussed. (tr-auth)

27391 RADIOISOTOPE POWER FOR SPACECRAFT APPLICATIONS CONTINUES TO GROW. Mahefkey, Edward T. Jr. SAE (Soc. Automotive Eng.) J., 74: 48-55 (May 1966).

The development of radioisotope-fueled power systems for space vehicles is discussed with emphasis on recent developments. The criteria for the selection of an isotope are outlined; and the characteristics of some of the most promising isotopes are tabulated, together with the characteristics of some future heat sources. Power conversion techniques are also considered with emphasis on thermoelectric and thermionic converters. (D.C.W.)

Separation and Production

See also CHEMISTRY — Separation Processes and Procedures

27392 (ORNL-TM-1475) ION OPTICAL DESIGN CONSIDERATIONS FOR AN INHOMOGENEOUS MAGNETIC FIELD ISOTOPE SEPARATOR. Dagenhart, W. K.; Whitehead, T. W. Jr.; Love, L. O. (Oak Ridge National Lab., Tenn.). May 1966. Contract W-7405-eng-26. 14p. (CONF-651135–5). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From American Physical Society, Southeastern Section, Charlottesville, Va.

The three-dimensional focusing properties of an azimuthally invariant, sector-type magnetic field having an inhomogeneity of n = 0.8, a radius of 24 in., and a total deflection angle of 180° were investigated. Computer calculated ion orbits for this system, using as parameters a 4-in. ion exit slit, ±2.5° radial beam divergence, and ±1° axial beam divergence, showed that this magnetic field produces an excellent focal pattern when the field is shaped through fifth-order terms. The design layout for a sector separator of the n = 0.8 type was determined, and the first (experimental) set of contoured shims was fabricated and installed. (P.C.H.)

27393 IDEAL CASCADE FOR ASYMMETRIC ISOTOPE SEPARATION. Takashima, Yoichi. Bull. Tokyo Inst. Technol., No. 69, 21-37(1965).

Some equations which are adaptable for cascading a number of asymmetric separating units were introduced. This ideal cascade is composed of both stages and steps, in which each stage consists of (s + 1) steps. The s is defined from the relation of $\alpha = \beta^s$, where α and β are the heads separation factor and the tails separation factor, respectively. The s or its reciprocal value is treated as an integer. (auth)

27394 PRODUCTION OF CARRIER-FREE RADIOACTIVE ISOTOPES WITH THE UNIVERSITY OF PITTSBURGH CYCLOTRON. Allen, A. J.; Cohen, B. L. (Univ. of Pittsburgh). Isotop. Radiat. Technol., 3: 85-7(Winter 1965–1966).

The cyclotron is used principally for accelerating deuterons to 15 Mev and isotopes are shown to be produced most efficiently by intercepting the circulating beam with an internal target inserted into the vacuum system. Beam currents up to 200 μa are available at the position used. Some typical radioisotopes and their estimated production rates are given. (M.C.G.)

27395 DETERMINATION OF THE ISOTOPIC CONCENTRATION OF AN ENRICHED NEON SAMPLE. Berenyi, C.; Comaniciu, N.; Birlogeanu, Maria (Inst. of Atomic Physics, Bucharest). Studii Cercet. Fiz., 17: 1231-3 (1965). (In Rumanian).

The photoelectric method which yields fast and precise results was used for the determination of the isotopic concentration of a sample enriched in ^{22}Ne. A Fabry-Perot type recording spectrophotometer with a 40-mm spacer was applied to resolve the two components of the λ = 5882 A line, located at 0.058 cm^{-1} from each other. An electrodeless U-shaped tube filled with mixture to be analyzed at a pressure of about 2 mm of Hg, placed in a liquid-nitrogen

filled Dewar flask served as the light source; a push-pull generator with a stabilized frequency of 30 MHz was used for excitation. As the two components corresponding to the two isotopes are well resolved on the interferogram, a graphic method could be used to evaluate directly their intensities, without recourse to a reference. The data indicated a ^{22}Ne content of (80.4 ± 1) % in the sample; the ^{22}Ne content of natural Ne was found to be (8.9 ± 0.9) %. The precision obtained exceeded that of the photographic method. (TTT)

27396 REACTOR-PRODUCED RADIONUCLIDES. Baker, P. S. (Oak Ridge National Lab., Tenn.). pp 129-42 of CONF-651111.

The production of radioisotopes for biomedical use by neutron activation or recovery of fission products is discussed. Reactors suitable for radioisotope production by neutron-induced reactions are listed, along with several radioisotopes that have been produced in this manner. (P.C.H.)

27397 ORNL 86-IN. CYCLOTRON. Pinajian, J. J. (Oak Ridge National Lab., Tenn.). pp 143-54 of CONF-651111.

The 86-in. cyclotron at the Oak Ridge National Laboratory continues to be one of the major sources of radioactive material for medical use in the United States. The products of this machine are neutron-deficient radionuclides; a major advantage being that they are produced in carrier-free form. By varying the type of target and its position in the cyclotron, several types of conditions can be established, which make the machine adaptable for production of a wide variety of radionuclides. The yields for 36 different radionuclides are tabulated. (auth)

27398 NUCLIDE GENERATORS. Richards, P. (Brookhaven National Lab., Upton, N. Y.). pp 155-63 of CONF-651111. (BNL-9592).

The nuclide generator is a convenient method of making short-lived isotopes available at long distances from the source of production. It serves as a continuous source of a short-lived isotope. Progress in simplifying generator construction and operating techniques is discussed. The disadvantages of these milking systems are few and are outweighed by the inherent advantages of being able to use short-lived isotopes in many medical procedures and by the increasing availability and variety of generator systems. (auth)

MATHEMATICS AND COMPUTERS

27399 (RISO-M-392) ABSTRACTS OF ALGORITHMS. Hansson, Leif (ed.) (Danish Atomic Energy Commission, Risoe. Research Establishment). Apr. 1966. 12p. Dep. mn.

Included is a collection of abstracts of all AEK procedures and subroutines in current use on GIER. (auth)

27400 (SC-DR-66-99) A VOLTAGE-SAMPLING-ANALOG-TO-DIGITAL CONVERTER (FOR RECORDING NONRECURRENT PULSES). (Sandia Corp., Albuquerque, N. Mex.). May 1966. Contract AT(29-1)-789. 35p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

A single-channel voltage-sampling analog-to-digital converter was developed with the intent of continued development into a multipurpose n channel digitizer. The basic n channel digitizer was planned for use on a variety of types of waveforms, the user selecting the appropriate number of modules depending on his application. Information on the evolution of a practical implementation of modular hardware is included. A realizable design for sampling, conversion, storage, and read-out modules is described. Contributing factors to the resultant absolute functional accuracy of this type of system are noted. They cause output readings to be in error by about ±1.0% to ±7.32% of full scale. In addition, inherent features which could be considered undesirable by some potential users are pointed out. (auth)

METALS, CERAMICS, AND OTHER MATERIALS

General

Refer also to abstracts 26816 and 26820.

27401 (AD-632362) LOW-TEMPERATURE REFRACTORY METAL-TO-CERAMIC SEALS. Report No. NJ-2769-0167-8. Final Report, January 1, 1964–January 15, 1966. Tentarelli, L. A.; White, J. M.; Buck, R. W. (Sperry Electronic Tube Div., Sperry Rand Corp., Gainesville, Fla.). Apr. 1966. Contract DA-36-039-AMC-03734(E). 253p. CFSTI $6.00 cy, $1.25 mn.

Results of a two-year study on low-temperature refractory metal-to-ceramic seals are reported. The development phase was concerned with: the effect of process variables; effects of ball milling on particle size and seal strength; effects of changes in Mn concentration; and the effects of compositional changes in the W–Mn–Fe metalizing system. Low-temperature mixes were adapted to silk screen and transfer tape metalizing techniques. Seal reliability was studied through heat cycling experiments. Numerous suspension mixes as well as metalizing solutions were investigated. The low-temperature process was found satisfactory on various alumina and beryllia bodies. Solution metalizing investigations were concerned with: concentration of salts; thickening agents; and solution stability. Feasibility of the low-temperature process was demonstrated by the fabrication of a number of hermetic seals used in production tubes. A comparison of low-temperature metalizing with conventional Mo–Mn metalizing process is presented. A theoretical phase involved: electron probe analysis of low-temperature metal-ceramic interface; x-ray diffraction techniques to detect compounds formed at the interface; various experiments designed to synthesize compounds formed at the interface; and micrographic and electron microscope techniques to detect internal microstructural changes that occur in a ceramic during heat cycling. Theories for adhesion between metals and insulators are discussed. An insulator-semiconductor-metal bonding model for metal-to-ceramic adherence was formulated during this study. Theoretical explanations concerning solution metalizing are presented. Conductivity experiments were designed to detect semiconductor material formed at the interface. A scratch test technique was developed to determine adhesion of metalizing films and theoretical explanations of the scratch test results are presented. (auth)

27402 (BM-RI-6789) FUSED-FLUORIDE ELECTROWINNING OF THORIUM-BASE ALLOYS. Kesterke, Donald G.; Fleck, D. C.; Henrie, T. A. (Bureau of Mines, Washington, D. C.). 1966. 14p. Bureau of Mines Free.

Low-melting Th-base binary alloys or metal solutions were prepared by two different techniques involving the electrolysis of ThO_2 dissolved in fluoride melts. Experiments were performed at 950 to 1250°C using electrolytes containing ThF_4 and various alkali and alkaline earth fluorides. In the first method, electroreduction of ThO_2 and deposition of Th on a Ni or Fe cathode formed a molten alloy that dripped off and collected on the bottom of the cell, or in a W cup. An electrocodeposition technique was used to prepare Th-base alloys or solutions containing Ni, Fe, Cr, or Mn. Electrolytic reduction of the component metal oxides and simultaneous deposition of the two metals on a W cathode yielded a liquid alloy product. Complementary experiments were performed on the fused fluoride electrowinning of dendritic Th from ThO_2 at 1075 to 1200°C in which Th crystals were recovered and arc-melted into buttons. Major contaminants were Al, C, Cu, Fe, O_2, and Si, totaling 0.2%. (auth)

27403 (BMI-1768) DEVELOPMENT OF CERAMIC-COATED-PARTICLE NUCLEAR FUELS. Summary Report. Townley, Charles W. (ed.) (Battelle Memorial Inst., Columbus, Ohio). Apr. 25, 1966. Contract W-7405-eng-92. 95p. Dep. mn. CFSTI $6.00 cy, $0.75 mn.

All aspects of the development of ceramic-coated-particle nuclear fuels were covered, with emphasis on pyrolytic carbon, alumina, and beryllia as the basic coating materials. Consideration was given to the reactor-physics requirements for the coated particles, methods of fabricating the materials, in-pile and out-of-pile evaluations, compatibility problems, radiation damage, and fission-product retention. PyC coatings were deposited on UC_2 and UO_2 particles in a fluidized bed by pyrolysis of hydrocarbon gases, primarily methane and acetylene. Satisfactory coatings were prepared at 950 to 2000°C over a wide range of deposition rates. Coating failure was eliminated by increasing the coating thickness to over 100 μ (on 200-μ-diameter substrates) and introducing porosity by use of either porous UO_2 substrates or multiplex coatings having an inner layer of 20 to 30 μ of porous carbon. Solid-fission-product retention, the major problem remaining with PyC, was improved by the use of oxide layers, SiC layers, or SiO_2 dopants to the coatings. Dense alumina coatings, 60 μ thick, deposited on 200-μ, porous (80% dense) UO_2 particles performed without failure to a ^{235}U burnup of at least 10 at. % at temperatures to 1100°C. Coating thickness and fuel density were selected to overcome low-temperature cracking found during irradiation experiments. Alumina was one of the best materials studied in retaining fission products, and the fractional release would not be expected to exceed 10^{-6} in a reactor. The BeO coatings had large grains and were unsuccessful in irradiation tests. Various coating conditions and grain-growth inhibitors or interrupters were used with only partial success in an effort to produce fine-grained coatings. The most practical coating material evaluated for use in a gas-cooled power reactor was pyrolytic carbon since it was superior to alumina in neutron economy and less expensive than either beryllia or alumina. With an inert-gas coolant, PyC-coated particles in a graphite matrix were not as limited in maximum operating temperature as alumina- or beryllia-coated particles. (auth)

27404 (BNWL-198) CERAMICS RESEARCH AND DEVELOPMENT QUARTERLY REPORT, JULY–SEPTEMBER 1965. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Contract AT(45-1)-1830. 132p. Dep. mn. CFSTI $4.00 cy, $1.00 mn.

Separate abstracts were prepared for the five sections of the report. (W.L.G.)

For abstracts of individual sections see: 27405, 27406, 27440, 27474, and 28827.

27405 (BNWL-198, pp 3.1-21) BASIC DEVELOPMENT OF PLUTONIUM FUELS. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Organic materials, such as oils, must be excluded from nuclear fuels. For test purposes, CCl_4 extraction of UO_2–PuO_2 fuel and infrared analysis of CCl_4 extracts were developed. Compaction efficiencies of UO_2 spheres were studied as a function of sphere size distribution. The third UN–20 wt % PuN (2130 w/cm linear) fueled assembly was discharged at 13.0×10^{20} fissions/cm^3. Consisting of four annular multiphase zones, the fuel evidenced grain boundary attack in the inner 10% of the sheath thickness. Alpha and β-γ autoradiographs showed gross radial variations both in Pu and fission fragment concentrations. Calculations indicate that irradiation of fast reactor fuels in thermal reactor flux will produce power generation density profiles, temperature profiles, and fuel burnup profiles that are severely nonprototypic. A study was made of the effect of fuel design parameters on the fabrication cost of plutonium fuel elements. According to an analysis of potential production methods for mixing nitride fuel elements, carbon reduction of the oxides followed by nitridation

in a fluidized bed reactor might be competitive with mixed carbide fuels. (W.L.G.)

27406 (BNWL–198, pp 4.1-42) PRTR FUEL ELEMENT PERFORMANCE AND FABRICATION. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Fuel testing is continuing in support of the High Power Density Program in the PRTR. Further development work was begun on magnetic force welded end closures for PRTR fuel elements. Radiometallurgical examination of the High Power Density thermocoupled fuel element showed that the temperatures at the bottom of the fuel rods were sufficient to cause fuel-thermocouple sheath reaction. Preliminary results are given of a study of molten urania–water reactions to determine the volume of hydrogen release, degree of urania fragmentation during rapid quench, and rate of water temperature and pressure increase. Three preliminary process flow charts were prepared relative to the fabrication of fuel elements for PRTR. Designated "Salt Cycle," "PEPPER," and "Rejuvenation," the three process cycles are applicable to other types of UO_2 or UO_2–PuO_2 fuel elements. (W.L.G.)

27407 (BNWL–207) METALLURGY RESEARCH SECTION. Quarterly Progress Report, October–December 1965. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 17, 1966. Contract AT(45-1)-1830. 143p. Dep. mn. CFSTI $3.00 cy, $1.00 mn.

Research is summarized on physical metallurgy, reactor metals, chemical metallurgy, and materials engineering. Sixteen separate abstracts were prepared for individual sections. Summaries of papers being prepared for publication on the following subjects are included: steady-state creep of plutonium, characteristics of the $\beta \rightarrow \alpha$ and $\alpha \rightarrow \beta$ transformations in plutonium, phase transformation damage in plutonium, kinetics of the $\alpha \rightarrow \beta$ and $\beta \rightarrow \alpha$ transformations of plutonium in the vicinity of equilibrium, and effects of irradiation and environment on the mechanical properties and hydrogen pickup of Zircaloy-2. (A.G.W.)

For abstracts of individual sections see: 27425–27427, 27475–27477, 27569–27577, and 28829.

27408 (DUN–800) AN EXPERIMENTAL, CONTINUOUSLY REGENERATED, ELECTROLESS NICKEL PLATING FACILITY. Jacky, G. F. (Douglas United Nuclear, Inc., Richland, Wash.). Feb. 15, 1966. Contract AT(45-1)-1857. 40p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

The electroless nickel plating process can be readily conducted in stainless steel equipment with suitable electrolytic passivation. High quality, adherent plate can be deposited up to a bath age of 1.4 ft^2 mils of nickel deposited per gallon of bath without interference from reaction products or trace metallic impurities. The process was based on an acid-type, lactate-buffered plating bath with sodium hypophosphite as the reducing agent. Major equipment items included a plating tank, a cooler tank, a chemical addition system, a recirculation pump, filters, and a solution heater. Heating equipment was designed to minimize the temperature of the heating surfaces; 15 psig steam was used as a heating medium. Instrumentation included automatic control of plating solution temperatures, recirculation rate, and chemical composition. Chemical composition was controlled by continuous pH measurement, with metered addition of concentrated solutions of nickel sulfate, sodium hypophosphite, and sodium hydroxide. Stainless steel surfaces were continuously passivated (to avoid deposition of plate) by making them anodic with a direct current of approximately 0.04 A/ft^2. Organic materials for packing and gasketing the system must be carefully selected, since the presence of organics in the plating bath may result in grossly poor plate adhesion and/or discoloration. In process studies, plate deposition rate was controlled to 0.5 ± 0.05 mil/hr, with major factors being bath temperature and pH. Plate thickness was controlled between 0.12 and 0.25 mil in plating over 500 ft^2. (W.L.G.)

27409 (GEMP–58A) HIGH-TEMPERATURE MATERIALS PROGRAM PROGRESS REPORT NO. 58, PART A. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). Apr. 29, 1966. Contract AT(40-1)-2847. 60p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Creep-rupture tests at 1100°C on irradiated W specimens at a fixed applied stress indicate the rupture life increases as the square root of the fast-neutron fluence. The time-to-rupture was increased by a factor of 8 following irradiation to 7.9×10^{19} nvt ($E_n \geq 1$ Mev). The ductility showed decreases with increases in fluence level. The creep-rupture properties of irradiated W specimens shielded with Cd were compared with similar unshielded specimens irradiated to the same fast fluence level. The effect of the larger thermal-fluence level of the unshielded specimen was to increase the duration of the second-stage creep period resulting in a greater rupture life and more ductility at rupture. This difference in creep-rupture properties is attributed to the relative difference in Re and Os concentrations. Annealing studies on the tensile properties at room temperature of Mo–50Re specimens irradiated at reactor ambient temperatures show that rapid recovery occurs in the 200 to 400°C range. Approximately 60% of the loss in ductility of specimens irradiated to 4.2×10^{19} nvt ($E_n \geq 1$ Mev) was recovered in a 400°C anneal. Annealing at 700°C reduced the yield and ultimate strengths to values slightly above the control specimen and the ductility to within 10%. Hastelloy N irradiated and tested at 760°C shows a factor of 10 decrease in rupture life compared to unirradiated (mill-annealed) material; this compares to a factor of 15 to 30 decrease for material irradiated and tested at 650°C. Hastelloy N stress relieved prior to irradiation at 650°C shows only a factor of three loss in rupture life compared to unirradiated material at the same temperature. Mill-annealed material shows a factor of 15 to 30 decrease after the same irradiation treatment. The diametral compression strength test, which requires very small specimens, was established as equivalent in value to the transverse bending test in defining the strength characteristics of ceramic materials. In comparison tests using BeO specimens having a range of grain sizes and densities, the diametral compression strength exhibited grain size, specimen size, and load rate dependences similar to those found with the bending modulus of rupture; however, the diametral compression test was somewhat more sensitive to specimen porosity and porosity type in specimens of 5 to 10 μs grain size. Further evidence was obtained of the beneficial effects of alumina–silica additives on the microcracking resistance of irradiated BeO. In 100°C irradiation tests, specimens containing 1 wt % of a low-silica glass more than doubled in strength at dosages up to 2.3×10^{20} nvt (≥1 Mev). The diffusion of rare gases in refractory metals is being studied by concurrent solution and diffusion of Kr (containing ^{85}Kr) in resistively heated arc-cast refractory-metal cathodes subjected to glow discharge. Radioautographs of samples prepared at 1700°C, the concentration profile of Kr in the samples, and Kr inventory-discharge voltage (300–500 V) relations indicate that Kr is absorbed in interstitial sites at the surface and transported through interstitial channels in the first 1000 to 1500 Å from the surface. Initial experiments on heating Zircaloy-4-clad UO_2 in steam to 1700°C show that at a heating rate of 3°C per sec only a relatively thin layer of the metal is oxidized to ZrO_2. Heating at 0.3°C per sec produces almost completely oxidized metal by the time the temperature has reached about 1750°C. Upon cooling, the cladding on the specimen heated at 3°C per sec fractured extensively whereas the specimen heated at 0.3°C per sec showed a strongly adherent ZrO_2 on the UO_2. Thermogravimetric measurements of steam corrosion of type 304 stainless steel in the temperature range of 1000 to 1250°C showed that the material initially reacts at a linear rate which soon (~6 to 28 min) changes to a parabolic rate. An activation energy of about 90 kcal/mole was calculated from these data. The oxide coating consisted of an Fe_2O_3 outer layer and an inner layer of predominantly Fe_3O_3. Effort was concentrated on determining the solubility of U in Fe–Cr–Al by isothermally equilibrating Fe–Cr–Al alloys containing 1 to 5% U. It appears that the solubility of U is less than 0.1% at temperatures from 600 to 1200°C. (W.L.G.)

27410 (GEMP-400A) HIGH-TEMPERATURE MATERIALS PROGRAMS. PART A. Final Annual Report. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). Feb. 28, 1966. Contract AT(40-1)-2847. 287p. Dep. mn. CFSTI $6.00 cy, $1.50 mn.

Separate abstracts were prepared for the 13 sections of the report. (W.L.G.)

For abstracts of individual sections see: 27411, 27429, 27430, 27443, 27485–27487, and 27582–27587.

27411 (GEMP-400A, pp 135-63) OXIDATION-RESISTANT FUEL ELEMENT MATERIALS RESEARCH. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation).

The air oxidation of Fe–Cr–Al–Y alloys is relatively independent of Cr content whereas the steam corrosion resistance is lowered as the Cr content is lowered. To retain steam corrosion resistance and freedom from embrittlement at low temperature, pre-oxidation in air is necessary. Increased strength and improved ductility in Fe–Cr–Al–Y alloys was achieved with powder prepared by atomization of the melt to obtain a fine dispersion of the YFe_8 compound. Fe–Cr–Al–Y alloys retain their high-temperature ductility after irradiation and the effects appear to be annealed out at about 350°C. (W.L.G.)

27412 (HW-73333) PRELIMINARY COST ESTIMATE FOR ELECTROLYTIC CONVERSION OF URANIUM OXIDE TO REACTOR-GRADE URANIUM DIOXIDE. Smith, P. W. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Apr. 16, 1962. Contract AT(45-1)-1350. 19p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

A conceptual plant was scoped for the electrolytic production of 3% enriched uranium dioxide. The flowsheet for a process using a LiCl–KCl melt, the engineering flow diagram, and the plant layout utilized are attached. From these an engineering estimate of the costs for commercial production of electrolytic uranium dioxide was made. The estimated operating costs for converting uranium oxide to reactor grade uranium dioxide electrolytically are $3.20 per pound. Approximately 70% are fixed costs and labor and the other 30% materials, electricity, and maintenance. A total cost of $5.00 per pound of electrolytic uranium dioxide is obtained by adding $1.80 per pound to the operating costs to provide a 15% return on the estimated $520,000 plant investment. The reduction in operating costs for processing natural uranium and the potential savings from the development of better container and cathode materials were also estimated. Costs are decreased to $2.60 per pound for processing natural rather than 3% enriched uranium. For the enriched uranium the costs would be reduced to $2.70 per pound assuming the development of high integrity construction materials. Base costs under present technology neglecting uranium inventory, use charges, and plant depreciation would be $2.30 per pound. The savings for handling natural versus 3% enriched uranium are firm since they involve only the decrease in uranium charges. The savings due to construction material improvements, however, reflect only the savings in material costs and do not indicate savings that might result from an improved process. (auth)

27413 (HW-75468) ALTERNATING-CURRENT HEATING OF MOLTEN SALTS. Brandt, D. C. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Nov. 28, 1962. Contract AT(45-1)-1350. 8p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

It was demonstrated that alternating current can be used to heat molten salts as effectively or more effectively than induction heating. The greatest advantage of a-c heating is the possible use of a containment vessel other than quartz. Two paddle electrodes permit the use of a frozen wall metal container while the electrode-pot arrangement utilizes a graphite pot and cylindrical electrode. The use of paddle type electrodes appears to be the most easily adapted to the salt pots in current use; however, a larger portion of the melt is occupied by electrodes than by the electrode-pot arrangement. Alternating current heating had no effect on UO_2 depositions by direct current on a separate pair of electrodes. Carbon contamination in the melt due to consumption of the electrodes may produce a deposit containing more than the maximum allowable carbon. The effects of temperature gradients in the molten salt using the electrode-pot arrangement on dissolution and deposition were not determined. A frozen salt can be melted by striking a carbon arc between the electrodes, which creates a molten path through which the current can flow. (auth)

27414 (ORNL-P-2108) ELECTRON BEAM FLOATING ZONE REFINING OF NIOBIUM. Reed, R. E. (Oak Ridge National Lab., Tenn.). Apr. 1966. Contract W-7405-eng-26. 44p. (CONF-660414-1). Dep. mn. CFSTI $2.00 cy, $0.50 mn.

From 2nd International Conference on Electron and Ion Beam Science and Technology, New York.

The electron beam floating zone refining technique was evaluated as a purification method for niobium. Resistance ratios, extensive chemical analyses, and mechanical properties were used to assess the importance of various purification mechanisms in this technique for refining niobium. The results showed that with the exception of Ta and W, the metallic impurities in Nb are removed mostly by evaporation to levels less than 1 ppM by the electron beam floating zone technique. Other factors affecting the purification process are also discussed. (P.C.H.)

27415 (TRG-Inf. Ser.-312) BIBLIOGRAPHY ON LIQUID METALS, 1958–1963. Fenney, S. H. (Reactor Group, United Kingdom Atomic Energy Authority, Risley (England)). Dec. 1965. 99p. Dep. BIS $2.60. HMSO 13s.

References (884) on liquid metals with particular emphasis on Na and Na–K alloys are given to reports, books, and journals published from June 1958 to Dec. 1965. The subjects covered include: analysis and purification; compatibility and corrosion; handling and safety; heat transfer; instruments; pumps; and properties. An author index is included. (P.C.H.)

27416 (UNC-5134(Vol.1)) CARBIDE FUEL DEVELOPMENT. Final Report, May 15, 1959–October 15, 1965. Strasser, A.; Stahl, D. (United Nuclear Corp., Elmsford, N. Y.). Oct. 15, 1965. Contracts AT(30-1)-2899; AT(30-1)-2303. 117p. Dep. mn. CFSTI $4.00 cy, $0.75 mn.

Heat transfer, nuclear, and preliminary cost studies were conducted to evaluate the potential of carbide fuels in fast breeder power reactors. Carbide fuel elements were substituted in the core of the Enrico Fermi Fast Breeder Reactor and their effect on the reactor heat transfer characteristics, nuclear characteristics, and fuel cycle cost was calculated and compared to U–10% Mo and PuO_2–UO_2 fuels. The calculations indicated that carbide fuels offer the promise of significant reduction in the fuel cycle cost of fast breeder power reactors by virtue of: their favorable heat transfer characteristics, i.e., high thermal conductivity and high melting point; and their high burnup potential. A process with economical mass production potential was developed to produce high density (UPu)C pellets. The starting materials UO_2, PuO_2, and C were blended and reacted at 1625°C to produce a (UPu)C clinker. The clinker was crushed to a fine powder, cold pressed, and sintered at 1525°C to 95% minimum theoretical density with 0.1 wt.% Ni sintering aid, or sintered at 1925°C to 91 wt.% theoretical density without sintering aid. The process was used to prepare samples at 5 and 20 wt.% PuC levels. Essentially stoichiometric UC powder was prepared by the C reduction of UO_2 in a He atmosphere. Attempts to prepare stoichiometric PuC by the C reduction of PuO_2 failed. Pu_2C_3 and $(UPu)_2C_3$ was readily obtained by reacting stoichiometric amounts of PuO_2, UO_2, and C. Sintering $(U_{0.8}Pu_{0.2})C$ at 1500°C with 0.1 wt.% Ni sintering aid produced a structure of monocarbide with a second phase of sesquicarbide. Sintering without sintering aid at 1900°C or higher produced monocarbide with a second phase of dicarbide. High temperature heat treatment (1750 to 2200°C) in vacuum caused the Ni to diffuse to the grain boundaries. In vacuum, the Ni could be evaporated. Some of the residual O_2 in pellets could be reacted by vacuum heat treatment and removed as CO, with an attendant slight

swelling and decrease in density. The lattice parameter of $(U_{0.8}Pu_{0.2})C$ did not change significantly in seven months. Tests up to 820°C for 4000 hr show that UC is compatible with type 304 stainless steel, 2¼ Cr–1 Mo steel, and pure Nb. The tests show that UC reacted with Inconel-X, Be, and Zircaloy-2. $(U_{0.95}Pu_{0.05})C$ was compatible with type 316 stainless steel, 2¼ Cr–1 Mo steel, pure Nb, and Nb–1 Zr alloy. It reacted with Zircaloy-2. The coefficient of expansion of $(U_{0.95}Pu_{0.05})C_{0.98}$ at 25 to 1400°C was measured as 12.6×10^{-6}/°C, and that of $(U_{0.95}Pu_{0.05})C_{0.98}$ + 1 wt.% Ni at 25 to 1400°C was measured as 12.2×10^{-6}/°C. The expansion curves were smooth and indicated that no transformations occurred. The liquidus temperature of $(U_{0.95}Pu_{0.05})C_{0.98}$ was determined to be 2535 ± 20°C. The solidus temperature was estimated to be 2500 ± 20°C. The vapor pressures of U and Pu over $(U_{0.95}Pu_{0.05})C_{0.98}$ were measured by the Knudsen effusion technique. The Pu vaporized at a higher rate than the U. The U vapor pressure over (UPu)C was similar to that of U over UC. The difficulty in maintaining constant sample composition at high temperatures for relatively long times increased the difficulty of the measurements. (W.L.G.)

27417 (UCRL-Trans–10036) PRODUCTION OF PURE AND ULTRAPURE METALS BY VACUUM DISTILLATION. Ivanov, V. E.; Papirov, I. I.; Tikhinskii, G. F.; Amonenko, V. M. Translated by Adam M. Mincer (Univ. of California, Lawrence Radiation Lab., Livermore), from Poluchenie Metodom Distillyatsii v Vakumme, Izdatel'stvo Metallurgiya, 1965. 320p. Dep. mn. CFSTI $7.00 cy, $1.50 mn. JCL $19.75 fs, $9.32 mf.

A description of the historical development of vacuum distillation is given and the terminology used to express the main concepts are defined. The theoretical basis, the equipment and general techniques used, and the technology for the vacuum distillation of individual metals and groups of metals are discussed. (W.L.G.)

27418 POWDER PREPARATION OF ALLOYS OF EUROPIUM OR STRONTIUM WITH SILVER, INDIUM, OR CADMIUM. Meixner, Johann (Max-Planck-Institut fuer Metallforschung, Stuttgart). Prakt. Metallog., 3: 124-6 (Apr. 1966). (In German).

A technique for the polishing of europium or strontium alloys containing silver, indium, or cadmium was reported. The method took into consideration the water sensitivity of these alloys and the extreme softness of indium. The polishing was carried out in an argon-filled glove box and an absolute alcohol suspension of alumina was used for the polishing. Aqueous chromic acid with nitric acid gave a good etching in the silver-rich and cadmium-rich alloys. The europium and strontium alloys could be tinted at room temperature. (J.S.R.)

27419 NUCLEAR APPLICATIONS OF NONFISSIONABLE CERAMICS. Proceedings of the Conference, Washington, D. C., May 9–11, 1966. Boltax, Alvin; Handwerk, J. H. (eds.). Hinsdale, Ill., American Nuclear Society, 1966. 495p. (CONF-660505).

Twenty-three papers presented at the conference are included. Topics covered include mechanical, physical, and chemical properties, fabrication processes, and applications. Separate abstracts were prepared for 22 of the papers. The remaining paper was previously abstracted for NSA. For the abstract number see CONF-660505 in the Report Number Index. (M.C.G.)

For abstracts of individual papers see: 26874, 26875, 26975, 27457–27461, 27524–27533, and 27612–27615.

27420 SYMPOSIUM ON ZIRCONIUM AND ITS ALLOYS. HYDRIDING AND IRRADIATION EFFECTS. Electrochem. Technol., 4: 193-274(May-June 1966). (CONF–651017).

Separate abstracts were prepared for the 12 papers presented at the conference. (W.L.G.)

For abstracts of individual papers see: 27421, 27435–27438, 27507, and 27599–27604.

27421 DEFORMATION BEHAVIOR OF ZIRCALOY-2 CONTAINING DIRECTIONALLY ORIENTED ZIRCONIUM HYDRIDE PRECIPITATES. Evans, W.; Parry, G. W. (Atomic Energy of Canada Ltd., Chalk River, Ontario). Electrochem. Technol., 4: 225-31(May-June 1966).

The effects of strain-induced directional zirconium hydrides on the deformation behavior of highly textured Zircaloy-2 containing hydrogen concentrations up to 200 ppM are described. In annealed specimens, zirconium hydrides lying parallel to the stress axis do not affect the tensile properties, but hydrides normal to the stress axis reduce necking ductility. Cold work and irradiation reduce the uniform elongation of the latter specimens; thus the hydrided cold-worked and irradiated specimens are brittle and weak at room temperature. At about 100 to 200°C, their strengths and ductilities are restored due to the hydrides' becoming ductile. Mechanisms are discussed for the brittle behavior and the restoration in properties. (auth)

27422 METHODS OF PREPARING URANIUM BY MAGNESIOTHERMY. Delange, Maurice; Huet, Henri; Vertes, Paul (to Commissariat a l'Energie Atomique). Canadian Patent 721,224. Nov. 9, 1965.

Uranium fluoride of low density is reduced to uranium with powdered magnesium. Degassing of the finely powdered fluoride under vacuum at about 250°C is the first step. The degassed powder is mixed with granular magnesium and an initiator before vibratory packing in a crucible followed by preheating. The exothermic reaction is started by placing the crucible in an electric furnace. From one half to one hour is required to secure uranium slugs of 95% purity. (F.S.A.)

Corrosion

Refer also to abstracts 26920 and 27482.

27423 (ANL–7100, pp 367-78) LIQUID-METAL LEVEL DETECTOR AND INDICATOR. Stillwell, L. W. (Garrett Corp., Phoenix, Ariz. AiResearch Mfg. Div.).

The design, development, and operation of two types of liquid-metal position detectors are described. The two types of detectors are: A portable, manually operated detector used for checking shipping containers, locating freeze or oxide plugs in piping, etc., where a continuous readout is not required; and a permanently mounted, automatic detector used to determine the level of liquid metal in the piping, tanks, etc., where a continuous readout of the liquid level is required. (W.L.G.)

27424 (ANL–7100, pp 455-79) INSTRUMENTATION FOR EVALUATING CAVITATION DAMAGE RESISTANCE AND HIGH-FREQUENCY FATIGUE OF REFRACTORY ALLOYS IN HIGH-TEMPERATURE LIQUID ALKALI METALS. Preiser, H. S.; Thiruvengadam, A. (Hydronautics, Inc., Laurel, Md.).

The design and calibration of the magnetostriction apparatus are described. Typical test results are given. (W.L.G.)

27425 (BNWL–207, pp 5.1-12) ENVIRONMENTAL EFFECTS. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Four zirconium alloys, Zircaloy-2, low-nickel Zircaloy-2, Zircaloy-4, and Zr-3 Nb-1 Sn, were exposed in the G-7 loop of the ETR for 36 days at 530°F in pH-10 lithium hydroxide at ~1 ppM oxygen. Coupons were exposed at fast flux levels of 1.9×10^{13} nv and 1.6×10^{14} nv. Samples also were placed in the loop at out-of-flux positions ~1 sec and ~1 min from the flux. Weight gains on the in-flux samples were up to 10 times the weight gains on corresponding samples at out-of-flux positions and were consistently higher at the higher flux positions. The Zr-3 Nb-1 Sn alloy showed a low susceptibility to flux-induced oxidation; one of two Zircaloy-2 alloys showed a high susceptibility at the higher flux level. There was essentially no difference in the radiation-induced oxidation of NPR Zircaloy-2, low-nickel Zircaloy-2, and Zircaloy-4. Heavily (86%) cold worked specimens behaved similarly to annealed specimens of the same alloy. There was no systematic effect of irradiated coolant on the corrosion behavior of coupons at out-of-flux positions. (auth)

27426 (BNWL-207, pp 5.13-15) ATR GAS LOOP SUPPORT. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Nichrome was found to oxidize according to a cubic rate expression at 1020 and 1120°C over a pressure range of 0.14 to 85 torr oxygen. At higher temperatures, oxide loss by evaporation is suspected to affect oxidation kinetics. The evaporation rates of Haynes 25 and Hastelloy X were determined in ultrapure He gas at 300 psi and 2050°F as a function of linear gas velocity. At 500 ft/sec the maximum evaporation rate is about half that found in vacuo. Decreasing the gas velocity decreases the evaporation rate. (auth)

27427 (BNWL-207, pp 5.16-18) PRP MATERIALS DEVELOPMENT. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Investigation of oxide thickness on sections of a discharged PRTR Zircaloy-2 process tube is in progress. Oxide thicknesses for the sections exposed to the highest neutron flux are a factor of 5 higher than the oxide thicknesses measured for sections with virtually no neutron exposure. Large differences in oxide thickness were also found between the inside and outside surfaces of the process tube. (auth)

27428 (EURAEC-1630) THE RELATIONSHIP OF NITROGEN CONTENT OF AUSTENITIC STAINLESS STEELS TO STRESS CORROSION. Quarterly Report No. 7. Ferry, B. N.; Eckel, J. F. (Virginia Polytechnic Inst., Blacksburg. Dept. of Metals and Ceramic Engineering). Mar. 1966. Contract AT(40-1)-3208. 29p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

Work Performed Under United States-Euratom Joint Research and Development Program.

The H_2-NH_3 composition was found at which no nitride case formed on type 308 stainless steel after 24 hr at 1000°F. Stressing type 304 stainless steel wires that contained various amounts of N_2 resulted in volume decreases of small magnitudes. Increasing the N_2 content of type 304 stainless steel from 0.04 to 0.26% produced a pronounced effect on the proportional limit and the rate of work hardening when tested at 150°C. (W.L.G.)

27429 (GEMP-400A, pp 165-7) PHYSICO-CHEMICAL STUDIES OF Fe-Cr-Al-CLAD FUEL SYSTEMS. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation).

Progress in the investigation of the reactions that can occur between oxidation-resistant Fe-Cr-Al alloys and UO_2 in the temperature region of 500 to 1200°C is reported. (W.L.G.)

27430 (GEMP-400A, pp 203-20) PHYSICO-CHEMICAL STUDIES OF CLAD UO_2 IN POTENTIAL MELTDOWN ENVIRONMENTS. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation).

The oxidation of Zircaloy-4 in steam when heated at 0.3°C per second produces a three-layered structure consisting of an outer layer of ZrO_2, an intermediate layer of ZrO_{2-x}, and an inner layer of metal. The intermediate layer has Sn or a Sn-rich alloy remaining which probably does not oxidize in steam because H_2O is more stable than SnO or SnO_2 at these temperatures. Isothermal corrosion of Zircaloy with steam at temperatures of 1200 and 1400°C is approximately parabolic with time. The tentative activation energy is calculated to be about 38 kcal/mole. Type 304 stainless steel, subjected to water vapor corrosion and heated to the melting point may bloat upon melting, especially if the heating rate is relatively low, i.e., 0.3°C per second. Molten Zircaloy and UO_2 react relatively rapidly at 1900°C and above. Upon cooling, the reaction products appear to be predominantly metal or a metallic phase, plus ZrO_{2-x}. The reaction rate of the molten Zircaloy with the UO_2 appears to be much slower than the Zircaloy steam oxidation reactions at similar temperature. (W.L.G.)

27431 (HW-72572) PRELIMINARY STUDY ON THE APPLICATION OF A FROZEN WALL AND ELECTROLYTIC HEATING TO MOLTEN SALT BATHS. Morrissey, J. E. General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Feb. 2, 1962. Contract AT(45-1)-1350. 12p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Containment of a fused salt (42 mole % KCl in LiCl) in a process vessel using the frozen wall principle to prevent corrosion to the vessel wall was successfully demonstrated for over 325 hours at melt temperatures of 420 to 550°C. It was noted that solid salt phase (frozen wall) was smooth and dense; had a graded thickness, symmetrical with respect to the heat flux, and was more difficult to remove, than to form, due to the poorer heat transfer characteristics of solid salt in comparison to the cold vessel wall. Electrolytic heating of molten salt baths was also successful. Alternating current flowing between two salt-immersed graphite electrodes directly heated the molten salt and a frozen wall was maintained at the water cooled vessel wall. Similarly, adequate heating of the melt to 550°C was obtained from two Firerod immersion heaters protected by quartz tubes. Corrosion during the tests was minimal. No corrosion of the 304L stainless steel container or graphite exposed to the molten salt was noted. Vapor phase corrosion of the graphite was observed and attributed to oxidation and/or salt attack. (auth)

27432 (NASA-CR-54892) MATERIALS FOR POTASSIUM-LUBRICATED JOURNAL BEARINGS. Quarterly Progress Report No. 9, April 22-July 22, 1965. Frank, R. G. (ed.) (General Electric Co., Cincinnati, Ohio. Space Power and Propulsion Section). Contract NAS-3-2534. 95p.

Nine 1000-hour isothermal capsule corrosion tests were conducted in vacuum (10^{-9} torr) at 800, 1200, and 1600°F to evaluate the compatibility of selected candidate bearing material combinations in a potassium Nb-1Zr alloy system. The material combinations tested were TZM alloy vs Carboloy 907, TZM alloy vs Grade 7178, and TZM alloy vs TiC-10% Nb. At the end of the 1000-hour exposure, the oxygen content of the potassium used to fill the capsules was analyzed to be less than 11 ppM as determined by the mercury amalgamation technique. Metallographic examination of all specimens exposed individually to potassium for 1000 hours at 1600°F was completed. No significant changes in microstructure were observed in any of the following materials as a result of the exposure to potassium liquid or vapor: TZM alloy, unalloyed tungsten, TiC-10% Mo, TiC-10% Nb, Lucalox (Al_2O_3), and TiB_2; slight surface attack to depths of 0.0002 to 0.0007 inch were observed in specimens of Carboloy 907, Carboloy 999, TiC, and TiC-5% W; some surface roughening was apparent with the K601 specimens exposed to potassium liquid; and a general chemical reaction between Zircoa 1027 and potassium was observed changing the color of the specimens from light yellow to dark grey throughout the entire cross section. Although no corrosion reactions were evident for the Grade 7178 and Star J materials, morphological changes due to the thermal exposure were observed. Solution/aging reactions occurred in the Star J material and possible coalescence of the eutectic phase was observed in Grade 7178. Visual examination and dimensional and weight data obtained from specimens exposed to potassium at 800 and 1200°F generally showed significantly less change than specimens exposed for 1000 hours at 1600°F. Operational checkout tests for the high vacuum friction and wear tester were completed and the first series of tests were conducted at temperatures to 1200°F, surface speeds of 500 SFM and loads up to 90% of the 0.2% CYS or UCS of the test material. Chamber pressures were maintained in the 10^{-9} to 10^{-10} torr range using standard, unlubricated MRC 7207 angular contact ball bearings in the main shaft. In the checkout tests, shaft speeds of 5000 rpm and specimen temperatures of 1600°F were achieved without difficulty. However, indications are that modification of the test facility by reducing the spring constant of the loading arm bellows and the use of force pickups that are more sensitive in the lower load range will improve the test results to be obtained for those materials which require testing a very light loads. Overall, no major modifications of the test facility appear necessary. (auth)

27433 (ORNL-P-1416) OXIDATION OF FUELED AND UNFUELED GRAPHITE SPHERES BY STEAM. Rutherford, J. L.; Blakely, J. P.; Overholser, L. G.

(Oak Ridge National Lab., Tenn.). [nd]. Contract W-7405-eng-26. 30p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

The oxidation of various fueled and unfueled graphite spheres (1.5-in. and 2.36-in. diameter) by steam was determined at 800, 900, and 1000°C using a partial pressure of ~730 mm(Hg) and flow rates of 600 to 1200 cm^3/min (STP) of steam. The fueled spheres contained pyrolytic-carbon coated UC_2 or $(U,Th)C_2$ particles dispersed in graphite matrices; the unfueled spheres were machined from ATJ and Speer Moderator-2 grades of graphite. Reaction rates were determined from weight changes and analyses of the effluent gases. The effect of burnoff on the reaction rate was found to be quite pronounced. The marked differences in the CO to CO_2 ratios observed in the effluent gases appear to be associated with both the degree of burnoff and purity of the graphite. BET surface area and mercury porosimetry data obtained for several oxidized unfueled spheres are included. (auth)

27434 (SC-RR-66-134) GEOMETRIC MEANS OF SPALL PREVENTION. Donner, Robert M. (Sandia Corp., Albuquerque, N. Mex.). Apr. 1966. Contract AT(29-1)-789. 24p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

The resistance of metal plates to spalling can be increased considerably by certain changes in the geometry. Drilling holes in copper and aluminum targets raised the stress input necessary for spalling about one order of magnitude. The holes may collapse and form high velocity jets under certain conditions. The experimental configuration and the results are presented in detail. (auth)

27435 HYDROGEN SOLUBILITY IN ZIRCONIUM ALLOYS. Erickson, W. H. (Chalk River Nuclear Labs., Ontario, Can.). Electrochem. Technol., 4: 205-11(May-June 1966).

The zirconium–2.5 wt % niobium–hydrogen system below 550°C was investigated by measurement of the hydrogen equilibrium pressures as a function of temperature and concentration. The $\delta + \epsilon$ hydride regions were found to be located at the same H/Zr ratios as in the zirconium–hydrogen system. The terminal solubility results appeared to be affected by supersaturation of the α-phase. Subsequently, it was demonstrated that a metastable state of supersaturation can exist more than 40°C below the solubility limit. (auth)

27436 THERMOCHEMICAL AND STRUCTURAL ASPECTS OF THE REACTION OF HYDROGEN WITH ALLOYS AND INTERMETALLIC COMPOUNDS OF ZIRCONIUM. Pebler, A.; Gulbransen, E. A. (Westinghouse Electric Corp., Pittsburgh). Electrochem. Technol., 4: 211-15 (May-June 1966).

The several ways hydrogen reacts with alloys and intermetallic compounds were reviewed based on hydrogen equilibrium pressure studies, x-ray crystal and micrographical structure analyses, and thermochemical principles. Examples were taken from the literature and from studies in these laboratories. The thermochemical stability of the alloy relative to that of either zirconium hydride or a new intermetallic hydride was the important factor in analyzing the hydrogen reaction. Four different types of hydrogen behavior were found. Thermochemical functions were given to describe the solid solubility of hydrogen and the first hydrides formed in the individual intermetallic compounds. (auth)

27437 HYDRIDE MORPHOLOGY IN STRESSED ZIRCONIUM AND THE INFLUENCE OF SPECIMEN SIZE ON DUCTILITY. Walters, G. P. (United Kingdom Atomic Energy Authority, Harwell, Eng.). Electrochem. Technol., 4: 216-21(May-June 1966). (AERE-R-5045).

A transmission electron microscopic study was made of the effect of stress on the orientation of hydride platelets in zirconium. Specimens were hydrogenated by steam treatment at 400°C and the hydrides precipitated by cooling under different applied tensile stresses. Precipitation was found to occur only on $\{10\bar{1}0\}$ planes, and a stress orientation effect was observed when the stress axis was normal to both $\{10\bar{1}0\}$ and $\{11\bar{2}0\}$ planes. The effect of a constant density of hydride platelets on the tensile properties of zirconium was studied as a function of specimen thickness. Hydriding gave slight increases in the 0.1% proof stress and ultimate tensile strength compared with heat-treated control specimens. Thin specimens were hardened slightly more than thick specimens. The decrease in elongation to fracture on hydriding was much greater in the thinner specimens, however. The hydrides were found mainly at the grain boundaries in all specimens and fracture occurred across hydride platelets and at hydride-matrix interfaces. Electron microscope replica studies revealed that thin specimens failed in a brittle manner whereas the thicker specimens showed typical ductile fracture by void growth and agglomeration. (auth)

27438 FRACTURE OF ZIRCONIUM CONTAINING ZIRCONIUM HYDRIDE PRECIPITATES. Beevers, C. J. (Birmingham Univ., Eng.). Electrochem. Technol., 4: 222-5(May-June 1966).

The fracture of zirconium containing hydride precipitates is considered. The fracture process is shown to occur in three stages: crack propagation within the hydride precipitates; propagation of the hydride cracks into the zirconium; and propagation of the zirconium cracks when a Griffith criterion is attained. Experimental observations and analysis of stage one have shown that conditions can be attained when the fracture of the hydride precipitates is more energetically favorable when the matrix is elastic than when it has become plastic. (auth)

27439 THE NITRIDING KINETICS OF ZIRCONIUM IN THE TEMPERATURE RANGE 750 TO 1000 DEG C. Ross, C. J.; Smeltzer, W. W. (McMaster Univ., Hamilton, Ont.). 32p. (CONF-651017-12). ORAU. Gmelin, AED-CONF-65-289-17.

From Electrochemical Society Meeting, Buffalo.

The nitriding properties of alpha and beta zirconium in nitrogen at 400 mm Hg pressure for exposures extending to 160 hr are reported. The kinetics may be represented by parabolic relations. The thicknesses of the zirconium nitride scale and the underlying layer of alpha zirconium-nitrogen solution on beta zirconium were determined by microscopic techniques. Nitrogen diffusion gradients in the metal were determined by micro-hardness measurements. Parabolic equations derived from two and three phase nitride-metal diffusion models accounted for the kinetics of nitriding, scale growth, and nitrogen solution in the metal. The diffusion constant of nitrogen in alpha zirconium was determined to be, $D(cm^2/sec) = 0.15 \exp(-54{,}100/RT)$. (auth)

Fabrication

Refer also to abstract 27495.

27440 (BNWL-198, pp 2.1-20) MATERIALS AND JOINING DEVELOPMENT. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

UO_2 was easily and quickly spheroidized into agglomerates up to 96% theoretical density by micronizing the UO_2 and using 0.1% TiO_2 additions. High energy-rate forming studies of BeO and BeO–UO_2 demonstrated that brittle ceramics can be pneumatically impacted to high density without gross laminar cracking. Pneumatic impaction studies were conducted on tungsten powders (5 and 100μ) to determine the optimum conditions for producing strong, crack-free bodies. Nickel and aluminum powders were consolidated during basic pneumatic impaction studies. In addition, a method was investigated for reliably determining the pressures applied during pneumatic impaction. (W.L.G.)

27441 (CEA-R-2997) REACTION AVEC L'AZOTE DES CARBURES D'URANIUM ET DE PLUTONIUM. (Reaction of Uranium and Plutonium Carbides with Nitrogen). Lorenzelli, Robert; Martin, Andre; Schickel, Roger (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Mar. 1966. 28p. Dep. mn.

Uranium and plutonium carbides reacted with nitrogen

during the grinding process preceding the final sintering. The reaction occurred even in argon atmospheres containing a few percent of residual nitrogen. The resulting contamination was responsible for the appearance of an equivalent quantity of higher carbide in the sintered products; nitrogen remained quantitatively in the monocarbide phase. UC can be transformed completely into nitride under a nitrogen pressure, at a temperature as low as 400°C. The reaction is more sluggish with PuC. The reactions that take place are: $UC + 0.8\ N_2 \rightarrow UN_{1.60} + C$; $PuC + 0.5\ N \rightarrow PuN + C$. (auth)

27442 (EURAEC–1551) PRODUCTION OF UO_2 POWDERS OF HIGH BULK DENSITY BY MELTING AND GRINDING AND THEIR PROCESSING INTO FUEL ELEMENTS. Final Report, July 1, 1963–June 30, 1965. Christ, R.; Duerrschnabel, W.; Hoppe, W.; Schikarski, L. (Nuklear-Chemie und -Metallurgie G.m.b.H., Wolfgang am Main (West Germany)). Contract 013-63-7-TEED. 73p. (EUR-2693). Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

The process development for the production of high particle density UO_2 powders that are suitable for vibratory compaction was continued. A furnace was constructed that melts either large diameter pressed compacts or simple powder charges by resistance heating in an Ar atmosphere. With this process the amount of scrap requiring chemical treatment is only about 1% per charge. Powder mixtures of varying particle size distributions were made from the melted UO_2 and used for vibratory compaction tests in stainless steel and Zircaloy-2 cladding tubes of various dimensions. Fuel densities of 87 to 88% of the theoretical were routinely obtained, although densities up to 90% were achieved in some cases. By swaging the vibratory compacted rods it was possible to obtain fuel densities of up to 93%, but damage to the fuel cans can occur. A comparison of the production costs revealed that the powder-filled fuel rods were about 6% more economical than those filled with sintered material. (W.L.G.)

27443 (GEMP–400A, pp 109-33) REFRACTORY-METAL ALLOY RESEARCH AND DEVELOPMENT. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation).

A wide range of alloy compositions in the W–Re–Mo system is available for application at high temperatures. Processing procedures were established for sheet, plate, and rods of the W–25Re–30Mo and W–30Re–30Mo alloys; final drawing operation for small seamless tubing is incomplete. Small diameter seamless tubing of the W–5Re alloy was fabricated. Six lots of commercial W–25Re sheet showed wide variation in quality; an average of 38% of each sheet was rejected. The weldability and ductility of Mo were improved through purification treatments aimed at lowering C and O_2 contents. (W.L.G.)

27444 (HW–83984) A PRELIMINARY ECONOMIC STUDY OF THE PREPARATION OF REACTOR GRADE PuO_2–UO_2 BY THE SALT CYCLE PROCESS. Bond, W. R. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Sept. 9, 1964. Contract AT(45-1)-1350. 21p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

A glove box facility was scoped to convert natural UO_2 and fully decontaminated PuO_2 to reactor grade mixed oxide fuel material ready for vibratory compaction into fuel rods. The plant was designed to meet the fuel requirements of a 1000 Mw(e) reactor with plutonium enrichments of up to 5 wt %. The plant was scoped to self contain any spread of plutonium. Equipment was designed and batch control limits were imposed to prevent the occurrence of a nuclear incident. A fixed capital investment of $1,010,000 was estimated from the plant layout and process equipment requirements. Private ownership of the plutonium and uranium feed materials were assumed with the reactor operator financing both the cost of the feed and associated inventory charges. The conversion cost for the production of 3 weight percent plutonium in natural UO_2 was estimated as $18.90 per kilogram of PuO_2–UO_2. The summation of the conversion cost, a $269 feed cost, and $4.60 inventory charge all on a per kilogram of PuO_2–UO_2 basis resulted in a product cost of $293 per kilogram of PuO_2–UO_2 for an enrichment of 3 wt % plutonium. The product cost represented the monetary investment in the product by the reactor operator as delivered to a fuel fabrication plant. Data are tabulated. (P.C.H.)

27445 (LA-DC–7159) CERAMIC–METAL BRAZES FOR USE AT 1100 DEG C. Hanks, G. S.; Kirby, R. S.; LaMotte, John D. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [1963]. Contract W-7405-eng-36. 26p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

Alloys and techniques were developed for making high-temperature brazed joints between Nb-1 Zr metal components and Al_2O_3 alone or with MgO or Y_2O_3. The brazing alloys used were primarily V–Nb, Nb–Ti, and V–Nb–Ti alloys. Techniques were developed for making reliable brazes using pure V and Pd metal as the braze material. Specimens of the V brazes made were subjected to 1100°C thermal cycles for a total elapsed time of more than 2000 hours, while maintaining a leak rate of 1×10^{-8} cc/sec He. From the results, it appears that the brazes developed are suitable for long-term service at temperatures of at least 1100°C. Also, some of the braze systems developed should provide reliable service at temperatures up to 1600°C. (P.C.H.)

27446 (MAB–206-M(3)) METALWORKING PROCESSES AND EQUIPMENT. Progress Report No. 3, March–October 1965. (Materials Advisory Board, National Academy of Sciences–National Research Council, Washington, D. C.). Oct. 31, 1965. 26p. CFSTI $2.00 cy, $0.50 mn.

The state of knowledge of the following aspects of metal processing are reviewed: lubrication in metal working, application of deformation theory to practice, limitations of the extrusion processes, and thin sheet rolling. (W.L.G.)

27447 (NMI–1264) FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. II. FABRICATION OF SEAMLESS TUNGSTEN AND TUNGSTEN–RHENIUM TUBING. Summary Technical Report for the Period July 1, 1963–June 30, 1964. Isserow, S.; Hunt, J. G.; Jenkins, R. G.; Geary, A. L. (Nuclear Metals, Inc., West Concord, Mass.). June 15, 1965. Contract AT(30-1)-2784. 249p. (NYO–2784-11). Dep. mn. CFSTI $6.00 cy, $1.25 mn.

Extrusion and drawing techniques were developed for seamless tubing of unalloyed tungsten and tungsten–25 wt.% rhenium with diameters below about 0.4-inch. Billets filled with molybdenum were used for both compositions. Four warm drawing techniques were found to be feasible for both materials. Significant progress in drawing resulted from the establishment of swaging as a practical method of pointing. The fabrication program was guided by metallurgical evaluations. Both wrought and annealed tubing were examined to determine their microstructures and mechanical properties, notably ductility as determined in the ring compression test. (auth)

27448 (ORNL-TM–1461) FABRICATION PROCEDURES AND PREIRRADIATION DATA FOR $(Th,^{233}U)O_2$-BEARING IRRADIATION RODS. Sease, J. D.; Olsen, A. R. (Oak Ridge National Lab., Tenn.). May 1966. Contract W-7405-eng-26. 32p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

For irradiation testing in the ETR process water at high thermal ratings, 18 fuel rods containing vibratorily compacted sol-gel (Th-3% $^{233}U)O_2$ were fabricated semi-remotely in the Kilorod Facility. These Zircaloy-2-clad rods are the first containing ^{233}U fuel that have been fabricated for the irradiation program on vibratorily compacted sol-gel thoria-base fuels. In the processing of fuel for vibratory compaction, the most significant uncontrolled variable is the effect of the cell atmosphere on sorbed gases in the fuel. To evaluate the effect of sorbed gas on the irradiation behavior of this fuel, one-half of the fuel rods fabricated were loaded with fuel that had been exposed to ambient air in normal handling; the other rods were loaded with fuel that had been re-

fired in Ar-4% H_2 just before loading. Pertinent preirradiation processing data on these rods are included. (auth)

27449 (SWRI-1228-4-17) INVESTIGATION OF THE EFFECTS OF FABRICATION ON THE PROPERTIES OF ERR PRESSURE VESSEL MATERIALS. Topical Report No. 2. McDonald, J.; Watson, P. D. (Southwest Research Inst., San Antonio, Tex.). Mar. 14, 1966. Contract AT (11-1)-1228. 70p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Investigations were made to determine the effects of fabrication history on the nil ductility transition temperatures and the low cycle fatigue strengths of the Elk River Reactor pressure vessel steels. The probable shell forming procedures for the pressure vessel were simulated for A302 Grade B steel by cold straining and warm (600°F) straining the material an amount equivalent to forming 3 inch thick material to a 7 foot diameter. Standard Charpy V-notch curves and standard S-N fatigue curves were developed for A302 Grade B steel for the various conditions. Low cycle fatigue curves and Charpy V-notch curves were determined for A105 Grade II steel trepanned from the ERR vessel flange and for A105 Grade II steel simulating the ERR pressure vessel nozzles. (auth)

27450 (UNC-5144) STUDY OF URANIUM-PLUTONIUM MONOXIDES. Final Summary Report. Forbes, R. L.; Fuhrman, N. (United Nuclear Corp., Elmsford, N. Y.); Andersen, J.; Taylor, K. (Carborundum Co., Niagara Falls, N. Y.). Jan. 31, 1966. Contract AT(30-1)-3305. 81p. (EURAEC-1566). Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Work Performed under United States-Euratom Joint Research and Development Program.

Uranium-plutonium monoxide compositions of the types $(U_{0.9}Pu_{0.1})(O_xC_{1-x})$ and $(U_{0.8}Pu_{0.1})(O_xC_yN_z)$ were synthesized by carbon and uranium reduction methods starting with UO_2-PuO_2 mixtures. Pure (UPu)O or PuO compounds, as well as nitrogen-stabilized uranium-plutonium monoxides $(U_{0.9}Pu_{0.1})(O_xN_{1-x})$, could not be synthesized. The maximum oxygen content found in essentially single-phase $(U_{0.9}Pu_{0.1})(O_xC_{1-x})$ was approximately x = 0.4. Higher monoxide oxygen contents, approaching x = 0.6, were found in materials containing 15% or more of a dioxide phase. Nearly single-phase $(U_{0.9}Pu_{0.1})(O_xC_yN_z)$ compositions were obtained when the intended oxygen content was no greater than x = 0.3 and the O/C atom ratio was no more than 1. $Pu(O_xC_{1-x})$ compositions were prepared having estimated oxygen contents as high as x = 0.6. Corrosion testing to evaluate these fuels for water-cooled thermal reactor application demonstrated that: in boiling water, the $(U_{0.9}Pu_{0.1})(O_xC_{1-x})$ materials hydrolyzed while $(U_{0.9}Pu_{0.1})(O_xC_yN_z)$ compositions with carbon contents less than y = 0.4 were essentially unaffected; and in 550°F water, all monoxide-type materials disintegrated. Typical monoxide-type compositions appeared to have higher room temperature thermal conductivities than those of $(UPu)O_2$ and UO_2. (auth)

27451 TUNGSTEN SINGLE CRYSTAL SHEET. Raymond, L. (Aerospace Corp., El Segundo, Calif.); Charvat, F. R. AIAA (Amer. Inst. Aeron. Astronaut.) J., 4: 895-9 (May 1966).

With the rapid advances in growing large single crystals from commercial purity tungsten powder using the Arc-Verneuil technique, fabrication of single crystal sheet becomes more of a reality, owing to progress in our understanding of the associated anisotropic substructural changes that occur during rolling. Starting single crystal billet sizes of $1\frac{1}{2} \times \frac{3}{8} \times 12$ in. already have been produced, with the potential final size unlimited because of the unique method of traversing the hot plasma source both reciprocally and vertically from the seed. Compared to polycrystalline material tungsten, sheet fabricated from single crystals has immediate advantages because of the absence of grain boundaries. Single crystal sheet can be rolled at temperatures between 700 and 1000°C; it is free of delamination; it possesses strength levels comparable to polycrystalline tungsten sheet and still has as much as 14% elongation at room temperature; it has the bend, ductile-to-brittle, transition temperature that is below room temperature; and it can be welded without affecting the monocrystalline nature of the crystal. Because of the anisotropic nature of single crystals, rolling planes and directions must be considered when selecting the orientation that best favors processing. This results in directional mechanical properties of the sheet which might be disadvantageous for some applications. Although still on a laboratory scale, the possibility of advancing the technology to produce large-size sheet looks promising. (auth)

27452 THE USE OF AN AUXILIARY METAL BATH FOR THE PRODUCTION OF HIGH-PURITY CARBIDE POWDERS OF THE IVa-VIa GROUP OF ELEMENTS. Kieffer, R.; Rassaerts, H. (Technische Hochschule, Vienna). Int. J. Powder Met., 2: No. 2, 15-22(Apr. 1966).

Production of large quantities of high-purity carbides, or solid solutions of carbides, by carrying out the process in an auxiliary metal bath in a carbon tube furnace in protective atmosphere or vacuum is described. Chemical analyses of carbides produced by solid-state reactions of the components, or produced in liquid metal baths, are compared. (auth)

27453 PRODUCTION OF METALLIC URANIUM TUBES. Lerouge, G.; Decours, J. (Commissariat a l'Energie Atomique, Saclay, Gif-sur-Yvette, France). Mem. Sci. Rev. Met., 63: 211-25(Mar. 1966). (In French).

The production of metallic uranium tubes by casting them in hot molds is described. This technique suppresses porosity but leads to a coarser microstructure. The alloy used was uranium with 1.1% molybdenum; the molds were heated at the top to give a coarser γ grain in this zone. The γ structure depends essentially on the rate of solidification and on the holding time in this region. (tr-auth)

27454 PLATING OF BERYLLIUM. Rothschild, B. F.; Nabors, R. G. Metal Finishing, 63: No. 7, 49 53(July 1965).

A plating process was developed to provide minimal metal removal, bridging of small surface defects, and good deposit adhesion in the plating of Be components for precision instruments and structural components for aerospace systems. The process consists of vapor degreasing at 188 to 190°F, baking at 165°F, chemical polishing in HF + HNO_3, cathodic cleaning, activation in $(NH_4)_2SO_4$, Zn immersion, Cu plating at 105°F, outgassing in vacuum at 310°F, overlay plating, and a second outgassing. Pit-free or near pit-free surfaces are obtained on hot pressed powder Be blocks using this plating cycle. The effect of defects can be minimized by prevention of bleed-out during the chemical processing step. This is accomplished by the use of plating solutions with a pH in the same range. A Cu strike step, particularly one employing ultrasonic solution agitation, helps to produce a sound deposit. Plating deposits are thin Zn, 0.0001 to 0.002 in. Cu, 0.004 to 0.008 in. Ni-P, 0.002 to 0.005 Cr, and 0.004 to 0.012 Fe. (Rev. Metal Lit.)

27455 DIFFUSION IMPREGNATION WITH BERYLLIUM. Zemskov, G. V.; Mel'nik, P. I. (Odessa Polytechnic Inst.). Metalloved. Term. Obrabotka Metal., No. 3, 62-4(Mar. 1966). (In Russian).

Iron, steels, and molybdenum were impregnated with beryllium in a powder mixture containing 65% Be, 30% Mg, and 5% $MgCl_2$. The impregnation was done at 800 to 1250°C for up to 14 hr. The thickness of the impregnated layer on all materials increased with increasing temperature and duration of the process. The microstructure of the impregnated layer on iron consisted of columnar crystals; the top portion consisted of an unetchable, white brittle layer of Be_2Fe_3 iron beryllide with a hardness of 1400 to 1500; the next portion consisted of a solid solution of beryllium in α-iron and of iron beryllides along the grain boundaries and within grains. The transition zone consisted of a solid solution of beryllium in iron with a hardness varying from 470 to 150 along the thickness. The impregnated layer on Kh18N9T steel had a hardness of about 750, which gradually decreased to about 100 along the layer thickness. The microstructure of the impregnated layer on another ZhS6-K steel consisted of four zones. In the surface zone, which had a dispersed structure and a hardness of 1400, BeNi nickel beryllide and probably other unidentified beryllides were formed. The next zone, closer to the base, also had

a dispersed structure and a hardness of 1135. The last two zones had an icicular structure and a hardness of 600. The impregnated layer on molybdenum had two clearly defined zones: the surface zone, consisting of the MoB_{12} compound with a hardness of 2640 to 2040, and the lower zone, consisting of the MoB_2 compound with a hardness of 2040 to 90. The beryllium-impregnated layers on iron, ZhS6-C steel, and molybdenum exhibited an increased oxidation resistance in air at 800 to 1200°C. The beryllium-impregnated layer on Kh18N9T steel did not improve the oxidation resistance of the steel, probably because of a low concentration of beryllium at the surface layer. (ATD)

27456 DIFFUSION BONDING OF ZIRCALOY-2 TO STEEL BY SWAGING. Brutto, E. (CISE, Segrate, Italy); Perona, G.; Sesini, R.; Volta, G. Nucl. Eng. Design, 3: 365-8(1966).

A metallurgical bond between Zircaloy and steel was obtained by hot swaging. This method, developed at first on flat specimens and then applied to tubular joints, gives diffusion layers having a very small thickness. Mechanical, thermal and corrosion tests on tubular joints 40 mm in diameter have given satisfactory results. The application of the process to larger joints is projected. (auth)

27457 NONCONVENTIONAL CERAMIC-FORMING METHODS. Blocher, J. M. Jr.; Bowers, D. J. (Battelle Memorial Inst., Columbus, Ohio). pp 305-27 of Nuclear Applications of Nonfissionable Ceramics. Boltax, Alvin; Handwerk, J. H. (eds.). Hinsdale, Ill., American Nuclear Society, 1966.

The nonconventional techniques discussed are vapor deposition, reaction sintering, high-energy-rate forming, hot isostatic pressing, and electrodeposition. Vapor-deposited products such as pyrolytic graphite, filaments, and whiskers of high-modulus materials, and encapsulated nuclear fuel particles are reviewed, and factors influencing the structure of vapor-deposited materials are discussed. Reaction sintering to form strong bodies of otherwise unsinterable materials such as silicon nitride should find increasing utility. High-energy-rate forming and hot isostatic pressing, which can be used to compact fluffy powders prior to conventional sintering, show promise for direct fabrication of useful ceramic bodies. It was concluded that electrophoretic and electrolytic deposition deserve further attention as potentially useful ceramic-forming methods. (auth)

27458 REVIEW OF CERAMIC-TO-METAL STRUCTURES. Reed, L. (Research and Special Engineering, Div. of Varian Associates, San Carlos, Calif.). pp 329-46 of Nuclear Applications of Nonfissionable Ceramics. Boltax, Alvin; Handwerk, J. H. (eds.). Hinsdale, Ill., American Nuclear Society, 1966.

Composition of seals for unusual environments as well as microwave tube uses is discussed. High-temperature environments considered include the alkali metals, mercury, chlorine, fluorine, bismuth iodide, alkali hydroxides, and air. Some hardware for actual end products is used to illustrate applications of these seals. (auth)

27459 POWDER PROCESSING AND SINTERING OF NONFISSILE CERAMICS. Coble, R. L. (Massachusetts Inst. of Tech., Cambridge); Aitken, E. A. pp 347-58 of Nuclear Applications of Nonfissionable Ceramics. Boltax, Alvin; Handwerk, J. H. (eds.). Hinsdale, Ill., American Nuclear Society, 1966.

The control of powder processing to give desired microstructures is interpreted (for high density) as requiring conditions that favor mechanisms of material transport that produce densification in contrast to those that do not. The need for purification, calcination and forming control, controlled atmosphere, heating rate, and firing temperature is illustrated from examples in the literature where these effects are shown to be critical. (auth)

27460 NONFISSIONABLE CERAMIC COATINGS AND COATING PROCESSES. Pentecost, J. L.; Hahn, H. (Melpar, Inc., Falls Church, Va.). pp 359-79 of Nuclear Applications of Nonfissionable Ceramics. Boltax, Alvin; Handwerk, J. H. (eds.). Hinsdale, Ill., American Nuclear Society, 1966.

Ceramic coating processes including pack cementation, flame spraying, slurry processes, enameling, and others are discussed in terms of the variety of materials capable of deposition and their use in specific types of application. Process limitations and advantages are discussed. Physical, chemical, thermal, and nuclear properties of selected coating and coating-substrate combinations are presented. Basic problems of measurement and reporting of coating properties are pointed out, and the need for development of improved testing methods and standards emphasized. Several examples of procedures and data obtained in use tests are illustrated. Some future coating needs in terms of materials, improved processes, and better methods of evaluation are suggested. (auth)

27461 HOT PRESSING (PRESSURE SINTERING) OF NONFISSIONABLE CERAMICS. Spriggs, R. M. (Lehigh Univ., Bethlehem, Pa.); Vasilos, T. pp 381-417 of Nuclear Applications of Nonfissionable Ceramics. Boltax, Alvin; Handwerk, J. H. (eds.). Hinsdale, Ill., American Nuclear Society, 1966.

Pressure sintering, or hot pressing, represents an important method of processing nonfissionable ceramics at subconventional sintering temperatures. Attention is given to the objectives and the factors affecting and controlling the process and its applications. Microstructural control, enhanced densification, composite fabrication, and pressure bonding are described as objectives of this process not readily attainable by conventional sintering. Recent results that contributed to an understanding of the mechanism of pressure sintering are described in terms of particle-size effects, density-time behavior, and preferred orientation. The role played by diffusion is described. An extension of pressure sintering into the ultrahigh pressure regime is also outlined. New and/or exceptionally dense polycrystalline solid phases, not otherwise achievable, appear possible. The applications resulting from pressure sintering are discussed. (auth)

27462 POWDER METALLURGY IN REACTOR TECHNOLOGY. Rutkowski, W. (Inst. of Nuclear Research, Warsaw). Postepy Tech. Jadrowej, 9: 321-31 (1965). (In Polish).

Several problems are reviewed; among others are the applications of powder metallurgy to the technology of nuclear fuels (U, Pu, Th, UO_2, uranium carbide, and dispersed fuels) and construction materials. (32 ref). (NSA of Poland)

27463 FUEL ELEMENTS MADE FROM U–Mo IN Al AND Mg–CLADDING OF U–Mo FUEL RODS. PART I. Hofman, A.; Wiaderny, M. (Inst. of Nuclear Research, Warsaw). Postepy Tech. Jadrowej, 9: 517-23(1965). (In Polish).

Melting and vacuum casting of U–Mo alloys, thermal treatments, mechanical properties, and dimensional stability are reviewed. (NSA of Poland)

27464 PREPARATION OF THIN-FILM SPECIMENS OF REFRACTORY METALS FOR TRANSMISSION ELECTRON MICROSCOPY. Hepfer, W. D. (Franklin Research Labs., Philadelphia). Trans. Amer. Soc. Metals, 59: 345-9(1966).

The preparation of thin-film specimens of refractory metals for transmission electron microscopy is described. The loss of material is extremely small, and is determined by the thickness of the diamond cut-off wheel. Jet polishing and final thinning of the refractory metals, molybdenum, tungsten, tantalum, and niobium, are discussed. The polishing solutions as well as the solutions used for the formation of depressions are described. Chemical polishing was found to give the best electron transparent foils of niobium and tantalum and their alloys. Jet polishing and electro-polishing techniques described may be used for all metals and many ceramic materials. (F.J.H.)

27465 EFFECT OF REARRANGEMENT IN LIQUID-PHASE SINTERED W–Ni–Cu ALLOYS. Brophy, J. H.; Prill, A. L. (International Nickel Co., Suffern, N. Y.). Trans. Met. Soc. AIME, 236: 805-6(May 1966).

To account for rearrangement shrinkage in liquid-phase

sintering of Cu–Ni–W alloys, the analysis of Brophy, Hayden, and Prill was applied. It was verified that the presence of a liquid phase in 90W–5Ni–5Cu alloys introduces a rearrangement shrinkage preceding the solution-precipitation process. After rearrangement is complete, the mass-transport path and the rate-controlling processes of the solution-precipitation stage are the same as they were in the absence of a liquid phase. (F.J.H.)

27466 WELDING CHARACTERISTICS OF ADVANCED COLUMBIUM ALLOYS. Gerken, J. M. (TRW Inc., Cleveland). Contract AF 33(657)-9446. Weld. J. (N. Y.), 45: 210S-26S(May 1966).

An investigation was conducted on the welding characteristics of four advanced commercial Nb base alloys, D-36, FS-85, Cb-752, and B-66 in approximately 0.020 and 0.060 in. thicknesses. Gas tungsten-arc and electron beam welding processes were employed in this program. Greatest emphasis was placed in the gas tungsten-arc welding process, in which most of the welding was performed in a vacuum purge atmosphere chamber. The main purpose of the program was to determine the effect of welding on the ductile to brittle transition temperature, tensile strength and hardness of each of these alloys. Arc welds were tested after a series of postweld heat treatments to determine the tendency of each to age embrittle on prolonged elevated temperature exposure as would occur in service. A number of arc welds were tested after applying an oxidation protective coating to determine the combined effect of welding and coating on ductility transition temperature. (auth)

27467 STRUCTURAL STABILITY OF WELDS IN COLUMBIUM-BASE ALLOYS. Yount, R. E.; Keller, D. L. (General Electric Co., Cincinnati). Contract AF33(657)-11223. Weld. J. (N. Y.), 45: 227S-34S(May 1966).

The solution and aging reactions and the effects of welding variables on these reactions in B-66 and D-43 Nb-base alloys were investigated. Changes in low temperature bend ductility and changes in microstructure were used as the principal measure of the thermal stability of these two alloys. (W.L.G.)

27468 METHOD FOR THE PRODUCTION OF FUEL ELEMENTS FOR NUCLEAR REACTORS. Winther, Aage Christian; Eriksen, Ole (to Atomenergiekommissionen). German Patent 1,213,064. Mar. 24, 1966. Priority date June 28, 1960, Denmark.

Fuel pieces are loaded into the can of the fuel elements with a metallic heat exchanging medium interspersed between them, and thereafter the can is heated to melt the said medium. The pile of fuel pieces is subjected to pressure while being heated. The interspersed medium is in the form of plates or discs. (Gmelin Inst.)

27469 NUCLEAR REACTOR FUEL ELEMENT AND METHOD FOR FABRICATION OF THE SAME. Mailet, Enemond (to Commissariat a l'Energie Atomique). German Patent 1,213,066. Mar. 24, 1966. Priority date Mar. 21, 1963, France.

The can of a cross-shaped fuel element held within a reactor channel by means of centering elements engaged in the salient parts, is provided between said salient parts with flanges having the shape of canted buckets, said flanges being cut by means of a rotating milling-tool, the axis of which is canted through an angle allowing the disengagement of the tool in order to shape, in a single operation, a subchannel for the coolant that circulates between the centering elements according to two helical paths of opposite directions. (Gmelin Inst.)

27470 METHOD OF MAKING A THERMIONIC DEVICE. Hill, Robert F.; Paprocki, Stan J.; Keller, Donald L. (to General Motors Corp.). U. S. Patent 3,243,292. Mar. 29, 1966. Filed Nov. 5, 1964.

A method for making an electron emitter for a thermionic device consists of forming a uniform mixture of from 10 to 80 vol % pulverized UC and from 20 to 90 vol % powdered Re, W, or a Re–W alloy, hermetically encapsulating the mixture in a Nb cladding lined with either one of the metals or the alloy mentioned, and heating the encapsulated mixture to cause it to sinter into a dense cermet body. A portion of the Nb cladding is then cut away to expose the cermet body. In order to prevent combustion, the mixing of the powdered metals should be carried out in a dry box; and furthermore, it is desirable that about 1% by weight of a suitable organic material such as Carbowax be included in the mixture. This, in addition to serving to coat the grains of UC and protect against combustion, serves as a binder for the mixture. (B.L.M.)

Properties and Structure

See also CHEMISTRY — Inorganic and Physical Chemistry
PHYSICS — Solid State Physics

Refer also to abstracts 27576, 28633, 28694, and 28695.

27471 (ACF–17) METALLOGRAPHY OF 5 PERCENT ALUMINUM–2.5 PERCENT TIN TITANIUM ALLOY. Echer, C. J.; Cooney, J. E.; Kish, A. J. (ACF Industries, Inc., Albuquerque, N. Mex.). Apr. 11, 1966. Contract AT(29-1)-1352. 17p. (ACF–412-286; CONF-660319–1). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From American Society for Metals Sessions, WESTEC Conference, Los Angeles.

Metallographic interpretation of 5 Al–2.5 Sn titanium alloy must be conducted on surfaces that represent the true structure. Preparation techniques when controlled and properly executed can consistently ensure proper evaluation and interpretation. Examination at high optical magnifications and the use of polarized light illumination are of special assistance in obtaining dependable results. The specific structures observed in 5 Al–2.5 Sn titanium alloy depend upon the thermal fabrication history of the material. Equiaxed alpha and/or transformed alpha structures, produced by working-temperature exposure in the all-alpha or alpha-plus-beta range, exhibit similar mechanical properties. These operations, when conducted at or above the beta transus, result in 5 Al–2.5 Sn titanium material with reduced strength levels and significantly lowered elongation and are to be avoided in the final fabrication stage. (auth)

27472 (BM-RI–6777) HIGH-TEMPERATURE COLUMBIUM AND TANTALUM ALLOYS. Babitzke, Herbert R.; Siemens, R. E.; Kato, H. (Bureau of Mines, Washington, D. C.). 1966. 16p. Bureau of Mines Free.

To develop alloys suitable for use at elevated temperatures, Nb and Ta were combined with W, Hf, V, Zr, and Ti, and the resulting alloys were evaluated with respect to fabricability, hardness, electrical resistivity, strength at elevated temperatures, oxidation resistance, and bend transition. Of the 23 compositions tested, Nb–20Hf–5W–10Ti exhibited superior high-temperature properties. A recrystallized sample of this alloy was fabricable at room temperature, had a strength of 44,000 psi at 1,200°C, and had an oxidation rate of only 7.7 mg/cm^2/hr at 1,000°C. (auth)

27473 (BNWL–184) THE EFFECT OF TEMPERATURE AND STRAIN-RATE OF THERMALLY ACTIVATED DEFORMATION IN HIGH-PURITY ALPHA IRON. Smidt, F. A. Jr. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 1965. Contract AT(45-1)-1830. 84p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Studies were made to determine the nature of defects produced in iron by neutron bombardment, and the mechanism by which moving dislocations interact with these defects so as to better understand how the mechanical properties are modified. The basic fundamentals of the theory of thermally activated deformation are reviewed, and the experimental methods used to obtain the parameters of interest are described. A useful equation tested for strain rates from 0.002 to 0.2 min^{-1} and temperatures from 77 to 325°K was derived from the temperature dependence of the flow stress. The equation also predicts the relations by which the activation volume and temperature dependence

of τ^* at constant strain rate should be given. Nonlinearity in the activation enthalpy-temperature relation, commonly observed in activation enthalpy analyses for bcc metals, arose from the failure of the assumption that the experimental activation volume is a good approximation to the true activation volume in the region where τ^* becomes small. It was concluded that the most probable mechanism of deformation in alpha iron over the range where the deformation is thermally activated is the nucleation of double kinks to surmount the Peierls stress hill. (P.C.H.)

27474 (BNWL–198, pp 1.1-22) CERAMIC FUEL RESEARCH STUDIES. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Two reactions were detected by DTA of PuO_{2-x} specimens. These reactions are believed to be the $\alpha - Pu_2O_3 \rightleftharpoons \alpha' - Pu_2O_3$ change at 875°C and the eutectoid reaction at about 300°C. Reflection electron micrographs were made of heated $PuO_{1.8}$. Structural changes observed at about 700°C may be related to the phase change required at this temperature by the phase diagram. Lattice parameters were measured for a series of UN–PuN solid solutions. A UN–PuN phase was produced by carbothermic reduction of the mixed oxides. Measurements were made on the equilibrium dissociation pressures in the Am–O system. Partial molar thermodynamic quantities were calculated for the solution of O_2 in AmO_{2-x}. At room temperature the system is diphasic, consisting of AmO_2 and cubic Am_2O_3. The self-radiation damage of Pu compounds was measured. Equations are given for the time dependence of the lattice damage of several Pu-containing materials. Thermal expansion measurements were made to 1290°C on pneumatically impacted specimens of a type 304 stainless steel–20 vol % PuO_2 cermet and to 1500°C on PuO_2. In addition to reversible expansion, both materials showed irreversible dimensional changes, which are thought to result from stress relief and sintering mechanisms. Irregularities in the cooling curve for one reduced PuO_{2-x} specimen established the occurrence of solid-state phase changes. The thermal diffusivity of several single crystal and polycrystalline UO_2 specimens were measured between 100 and 1100°C. Thermal conductivities, calculated from the thermal diffusivity data, show a wide difference below 1000°C. The differences are relatively small at the higher temperatures. A special phosphate glass showed a wide scatter in thermal diffusivity data measured between 25 and 600°C. Changes occurring during heating suggested a change in composition or structure at the higher temperatures. (W.L.G.)

27475 (BNWL–207, pp 3.1-6) PLUTONIUM PHYSICAL METALLURGY. Bowman, F. E.; Kissinger, H. E.; Mastel, B.; Nelson, R. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

High precision resistivity measurements on Pu showed that beta phase contains significant amounts of retained alpha at relatively high temperatures. Distinct differences in beta formed from alpha and beta formed from gamma were revealed by the resistometric studies. During $\beta \rightarrow \gamma$ transformation, resistance fluctuates and assumes values both above and below the values for either pure beta or gamma. Slip lines developed on polished, highly textured alpha specimens deformed by compression are being related crystallographically to the texture. For comparable deformation by compression, considerably different loads are required depending on whether the load is applied parallel or perpendicular to the 010 texture direction. (auth)

27476 (BNWL–207, pp 3.14-16) DAMAGE MECHANISMS. Smidt, F. A.; Bennett, W. S. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

A purification procedure employing a ZrH_2 exchange reaction was applied to Fe and Mo to reduce the effect of interstitial impurities on thermally activated flow processes. Marked reductions in yield strengths were obtained by purifying samples of Ferrovac E and Battelle zone-refined Fe in hydrogen at 850°C, but little change was obtained in Mo treated at 1300°C. (auth)

27477 (BNWL–207, pp 6.7-12) USAEC–AECL COOPERATIVE PROGRAM. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Brittle fracture data were obtained for hydrided and nonhydrided Zr-2.5 wt.% Nb alloy tubing in the 30 and 60% cold-worked condition. The brittle fracture temperature of the tubing in the 60% cold-worked condition is lower than for the 30% cold-worked condition, and the difference is believed to be attributable to differences in hydride impurity. (auth)

27478 (CEA–R–2941) BETONS TRES LOURDS A BASE DE RIBLONS. (Very Heavy Scrap Iron Concretes). Dubois, Frederic (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Apr. 1966. 93p. Dep. mn.

A detailed description is given of the iron scrap produced by industrial stamping operations. The compositions and properties of mortars containing steel shot as all or part of the fine aggregate are given. The compositions and properties of concretes composed of iron scraps as the aggregate and mixed with cast-iron, magnetite, barite, limonite, or boron are presented. Diagrams are given that make it possible to find the proportions of the constituents of these concretes as a function of the required density. (W.L.G.)

27479 (CONF-660406–1) FRACTURE TOUGHNESS DETERMINATIONS OF A-302B AND Ni–Mo–V STEELS WITH VARIOUS SIZE SPECIMENS. Mowbray, D. F. (Knolls Atomic Power Lab., Schenectady, N. Y.); Brothers, A. J.; Yukawa, S. (General Electric Co., Schenectady, N. Y. Materials and Processes Lab.). [1965]. Contract W-31-109-eng-52. 37p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

From ASME Metals Engineering Conference and AWS 47th Annual Meeting and Welding Exposition, Cleveland.

Fracture tests were conducted on three steels obtained from heavy-section pieces over a range of test temperatures using single-edge notched (SEN) specimens under tensile loading and notched-bar (NB) specimens in bending. The SEN tests were performed on specimens 0.125 and 0.4 inches thick plus a few specimens 0.020 inches thick. In the NB series Charpy-sized specimens (0.4 inches square) were tested at various temperatures with additional tests on smaller and larger specimens up to six inches square at selected temperatures. All specimens were provided with a fatigue precrack at the tip of the notch. The tests were conducted to determine the capability of various size specimens for providing valid plane-strain fracture toughness (G_{Ic} or K_{Ic}) values at various temperatures for these steels. At very low temperatures all specimens gave similar K_{Ic} values. With increasing temperature, K_{Ic} values obtained from the larger specimens remained relatively constant and then increased rapidly. At higher temperatures within this range, valid K_{Ic} values could not be measured with small specimens. Two possible methods of estimating K_{Ic} at these temperatures from small specimen data are discussed. (auth)

27480 (DUN-SA–10) EVALUATION OF A PLASTIC FOAM MAGAZINE FOR HANDLING NUCLEAR FUEL. Jensen, H. F. (Douglas United Nuclear, Inc., Richland, Wash.). Apr. 15, 1966. Contract AT(45-1)-1857. 15p. (CONF-660706–1). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From 3rd Washington State Univ. Pacific Northwest Plastics Workshop Meeting, Richland, Wash.

Experiences in the development and use of plastic foams for handling nuclear fuels are related. The effort was a near success and would have been but for key breakdowns in communications, coupled with a lack of appreciation for the desired goal and lapses in follow-up, which seriously affected the timing and competitive position of the plastic unit. (P.C.H.)

27481 (EURAEC–1419(and App.)) BASIC STUDY ON A FEW EMBRITTLEMENT FORMS AFFECTING JOINTS WELDED ON HIGH RESISTANCE STEEL; AND ON MEANS OF IMPROVING THEIR MECHANICAL PROPERTIES. Final Report. (Societe des Forges et Ateliers du Creusot,

Paris (France)). May 1965. Contract 073-61-12-RDF. 87p. (EUR-2368). Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Results of efforts to produce a weldable low-alloy steel with high strength in the quenched or tempered states are reported. Approximately 70 experimental castings were made of a steel having the base composition of 0.15% C, 1% Cr, 1% Mn, 1% Ni, and 0.5% Mo plus an alloying element, or an element to control the austenitic grain size, or one of the common impurities. The effects of 19 different elements on the ductility of the base steel in the as-quenched or tempered states were investigated. (W.L.G.)

27482 (EURAEC-1453) [MECHANICAL PROPERTIES OF STEELS]. Quarterly Report No. 4, July–September 1965. (Compagnie des Ateliers et Forges de la Loire, Paris (France). Departement des Recherches). Contract 033-64-9TEEF(RD). 48p. (EUR-2665). Dep. mn. CFSTI $2.00 cy, $0.50 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Progress is reported in the investigation of the effects of composition on the mechanical properties and stress-corrosion resistance of two groups of high-purity stainless steels. Both groups contain steels with Si and/or Mo alloying additions, but one group is completely austenitic, while the other steels contain both austenitic and ferritic phases. The mechanical properties tests included yield strength and elongation measurements at 20 to 500°C, measurements of the impact strength at room temperature of samples heat treated at 300 to 600°C, and the stress embrittlement of the austeno-ferritic steels heated at 400°C and of the austenitic steels heated at 400 and 600°C. Stress-corrosion tests were performed in solutions of $MgCl_2$ at 153°C, NaCl at 200°C, and $FeCl_3$ at 350°C. (W.L.G.)

27483 (GA-6332) DEFORMATION AND FRACTURE OF PYROLYTIC CARBONS DEPOSITED IN FLUIDIZED BEDS. Bokros, J. C.; Price, R. J. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). May 21, 1965. Contract AT(04-3)-167. 42p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

Pyrolytic carbon formed by the pyrolysis of hydrocarbon gas in a fluidized bed is used as a coating for nuclear fuel particles. An investigation was undertaken to relate the mechanical properties of such deposits to their structure, which in turn depends on the deposition conditions and subsequent heat treatment. Carbons deposited from methane between 1350 and 1925°C were characterized according to their density, degree of preferred orientation, apparent crystallite size, and micrographic appearance (laminar, isotropic, or granular). Stress-strain curves to fracture were obtained from room-temperature three-point bend tests on planar samples and the mode of fracture was investigated by optical microscopy and electron microfractography. Both the elastic modulus and the fracture stress decreased in progressing from laminar to isotropic granular structures, whereas the fracture strain was highest in the isotropic deposits. Annealing at temperatures between 1700 and 2800°C was found to change greatly the properties of only the high-density laminar structures deposited from high methane concentrations, where the elastic modulus and fracture stress were reduced by annealing. The mechanical properties of the various carbons are discussed in terms of their structure. (auth)

27484 (GA-6542) DIFFUSION OF FISSION PRODUCTS (AND TRANSMUTATION PRODUCTS) IN NONFUEL MATERIALS. A REVIEW. Simnad, M. T.; Zumwalt, L. R. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Dec. 15, 1965. Contract AT(04-3)-187. 186p. Dep. mn. CFSTI $5.00 cy, $1.00 mn.

A review is presented on the kinetics and mechanism of diffusion of fission products and transmutation products in nonfuel (nonfissile) materials. The topics covered include theoretical studies and the derivation of the diffusion equations, the influence of irradiation damage, and the formation of inert gas bubbles. The materials in which the diffusion processes were studied include dispersion-type fuel bodies, cladding and structural materials, and moderator, reflector, and control materials. These are reviewed under the classifications metallic, ceramic, and carbon materials. The concomitant changes in some other properties as a result of the diffusion of fission products and transmutation products are also discussed. (243 references). (auth)

27485 (GEMP-400A, pp 21-61) HIGH-TEMPERATURE REACTOR MATERIALS RESEARCH. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation).

The stress-rupture and creep characteristics for arc-cast W sheet were determined for temperatures from 1600 to 3000°C in H_2 with rupture times from 1 to 250 hr. Linear isotherms were obtained on logarithmic coordinates at all temperatures except at 2000 and 2200°C. Further evaluations in this temperature range indicate that the transition temperature for the mechanisms of creep in W is 2000°C (0.62 T_m). Values for the constants in the parabolic creep law were determined for the first stage of creep for arc-cast W from 1600 to 3000°C. The apparent activation energy for the creep of arc-cast W from 2000 to 2800°C was determined to be 160 kcal/mole. Stress-rupture results for arc-cast W and arc-cast Mo data, when compared on the basis of homologous temperature, show them to have the same rupture life at the same stress. It is therefore concluded that the true high-temperature creep-rupture properties of W and Mo are obtained from arc-cast materials. Creep-rupture evaluations of commercial W–25Re sheet purchased from all known vendor sources in 1964 were performed at 1600 and 2000°C to determine the consistency of the material as of that time. The results indicate a wide variation in the time required to give the same value of strain for the same conditions of test. At both temperatures, the ductility, of the arc-cast material is considerably greater than that of the powder metallurgy material (based on rupture elongation). Creep-rupture evaluations of W–Re–Mo alloys were performed to determine the effect of alloy compositions on the creep resistance of the materials. Alloy compositions varied from W–26Re to W–29Re with 0, 10, and 20% Mo. Tests performed at 1600°C showed the W–26Re alloy to be the most creep resistant. At 2200°C, the W–27Re–20Mo alloy was the most creep resistant. The specimens tested at 1600°C show a decrease in grain size with increasing Re content whereas the grain size increased as the Mo content increased. The specimens tested at 2200°C show no significant change in grain size with increasing Re content, but an increased grain size is observed as the Mo content is increased. A fairly detailed analysis was made of equation forms capable of expressing first-stage creep behavior using experimental data for different materials in the temperature range from 14.5 to 2800°C. Of the 15 different equation forms studied, six provided excellent correlations, with the de Lacombe equation providing the best results. A substructure study was made of arc-cast Mo rod, creep-rupture tested at 2200°C. Tested specimens were highly polygonized and contained small subgrains with relatively large tilt-angle boundaries. Back-reflected Laue patterns clearly reveal the differences in the subgrain structure at different stress levels and a strong [110] orientation. The plane of fracture was {001} with a ⟨110⟩ direction along the rod axis and ⟨$\bar{1}$10⟩ along the fracture edge. Etch-pit studies of arc-cast Mo sheet creep tested at 2200°C showed that grains with a {111} orientation etched most readily, while grains etched near the {112} orientation showed practically no etching. The same material only annealed at 2200°C (no creep testing) had a high density of etch pits for grains with a {012} and {113} orientation while grains with angles larger than 30 degrees to the {001} showed almost no etch pits. Of the various refractory metals and alloys evaluated at 1600°C, W–25Re has the greatest rupture strength and unalloyed Mo the least. Thermal conductivity measurements for Mo and W–40UO_2 (vol. %) were obtained at temperatures from 900 to 2000°C in a radial heat flow apparatus. The data obtained for Mo are in reasonably good agreement with data in the literature. (W.L.G.)

27486 (GEMP-400A, pp 185-201) EVALUATIONS OF THE PLASTIC FATIGUE PROPERTIES OF HEAT RESIS-

TANT ALLOYS. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation).

Experimental procedures were developed with the ability to generate accurate and reproducible uniaxial low-cycle fatigue data at elevated temperature using push-pull loading and diametral strain control. An exploratory test program was completed and systematic testing of type 304 stainless steel was initiated. (W.L.G.)

27487 (GEMP–400A, pp 263–8) HIGH-TEMPERATURE THERMOCOUPLES AND ELECTRICAL MATERIALS RESEARCH. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation).

The resistivity of ThO_2 was found to be a function of oxygen partial pressure and temperature and approximately two orders of magnitude smaller than BeO. The low activation energy of BeO measured, however, indicated that small amounts of impurities were controlling its resistivity. If these impurities can be removed, it is believed that much higher BeO resistivities can be obtained. (W.L.G.)

27488 (IITRI–578P27-17) YIELD PHENOMENA AND FRACTURE OF HYDRIDED ZIRCONIUM. Quarterly Report, January 1, 1966–March 31, 1966. (IIT Research Inst., Chicago, Ill.). May 4, 1966. Contract AT(11-1)-578. 25p. (IITRI–B6035-17; EURAEC–1643). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

The temperature dependence (−200 to +200°C) of yield point in high-purity polycrystalline zirconium (~0.004 to 0.009 mm average grain diameter) was investigated. The results were correlated with the strain-hardening coefficient. Both yield point and strain-hardening coefficient showed a regular, continuous-type relationship with temperature over the entire grain size range. The results accentuated the first-order importance of fine grain size in yield point occurrence. Also, the strain-hardening rate was generally reduced by increasing temperature, and the effect was able to generate a yield point, when the grain size was permissive. The results bolster the credibility of the Johnston-Hahn model as a basis for explaining yield point occurrence in zirconium. (P.C.H.)

27489 (LA-DC–6807) SOLID SOLUTION CARBIDES OF URANIUM AND ZIRCONIUM. Davidson, K. V.; Riley, R. E.; Taub, J. M. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [nd]. Contract W-7405-eng-36. 22p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Various chemical reaction techniques used for the production of $(UC)_x(ZrC)_y$ powder are described. Also reported are the analytical results used to evaluate the quality of the product prepared by each technique. A detailed account is given of the arc-melting of elemental constituents, and the subsequent thermal treatments utilized to remove extraneous phases. Analytical results are reported for the powders produced from arc-melted buttons showing the reproducibility attainable by this procedure. (auth)

27490 (LA-DC–6901) COMPATIBILITY OF REFRACTORY METALS WITH SOLID SOLUTION UC–ZrC AT ELEVATED TEMPERATURES. Davidson, K. V.; Riley, R. E., Taub, J. M. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [1964]. Contract W-7405-eng-36. 20p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

The results of time temperature thermal treatments designed to investigate the compatibility of refractory metals such as W, Mo, and Nb in the presence of solid solution UC–ZRC are reported. Details of the techniques used to fabricate specimens are also given. Compatibility was determined by time-temperature stability tests. Molybdenum and Nb reacted with (UC)(ZrC) at temperatures as low as 1800°C, even for short periods of time. However, results with W showed that a reaction occurred at temperatures as low as 2000°C for sintering times as short as 2 hr. However, the usefulness of W in the presence of (UC)(ZrC) is questionable. (P.C.H.)

27491 (LA-DC–7161) COMPATIBILITY OF UO_2 AND UO_2 + U WITH TUNGSTEN CRUCIBLES. Eash, D. T. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [nd]. Contract W-7405-eng-36. 18p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

An investigation on the compatibility of molten uranium dioxide with tungsten showed that very little reaction occurs between the two materials when the uranium dioxide is sealed in vacuum inside tungsten crucibles and heated to 3000°C for a period of one week. Furthermore, mixtures of uranium metal and uranium oxide containing up to 30 wt % U can similarly be sealed and heated to 3000°C for at least 15 minutes without undergoing severe reaction with the tungsten. (auth)

27492 (NASA-CR–471) A SEMI-ATOMISTIC MODEL FOR FLAW-INDUCED FRACTURE IN NON-DUCTILE MATERIALS. Schuerch, H. (Astro Research Corp., Santa Barbara, Calif.). May 1966. Contract NASw-652. 32p. CFSTI $2.00 cy, $0.50 mn.

A semi-atomistic model is proposed for the nonductile failure of materials based upon an analysis of static and dynamic stress concentrations in uniaxial fiber-matrix composite materials. In this model the finite spacing of bonds is accounted for in the direction of a crack or flaw, while the material is considered as continuous in the perpendicular direction. An elementary, two-dimensional analysis based on linear force-displacement laws shows, that the stress concentration is dependent only upon the digital quantity of the number of adjacent, broken filaments or bonds, and is independent of the spacing and of the relative elastic properties of the fiber and matrix. The form of the static stress concentration factor: $K_n = \sqrt{\pi/2}\,\sqrt{n} = \sqrt{\pi/2}\,\sqrt{c/d}$ where n is the number of adjacent broken bonds, c is the crack depth, and d is the bond spacing, is formally equivalent to that obtained using relations given by Griffith and Charles. The results of the elementary analysis are of sufficient significance to warrant extension of the theory to nonlinear force elongation, and to account for temperature, stress corrosion, and static fatigue effects. In addition, experimental verification of this theory should be undertaken using both covalent and ionically bonded materials, as well as metals under conditions where nonductile failure occurs. (auth)

27493 (NASA-CR–54918) MEASUREMENT OF THE PERMEABILITY OF TUNGSTEN TO HYDROGEN AND TO OXYGEN. Final Report. Aitken, E. A.; Conn, P. K.; Duderstadt, E. C.; Fryxell, R. E. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). May 1966. Contract NAS3-6216. 49p.

Permeation rates of hydrogen through arc-cast tungsten were measured at temperatures from 1300 to 2600°C with hydrogen pressure differentials of 1 and 0.1 atmospheres across isothermal membranes. Rates were nearly proportional to square root of pressure, inversely proportional to membrane thickness, and temperature dependent according to the equation: $P = 33.2 \exp(-33{,}000 \pm 1000/RT)$ where: P = permeation coefficient in cc (STP)-mm/cm^2-min-atm$^{1/2}$, R = gas constant in calorie/mole-°K, and T = absolute temperature in °K. Permeation rates of oxygen through tungsten were studied in the temperature range 2000 to 2600°C. Sealed tungsten capsules containing known quantities of tungsten oxide were tested in helium and hydrogen, then broken open and the remaining oxygen assayed. A permeation coefficient was calculated for each capsule based on test conditions, initial and final oxygen contents, and oxygen pressures calculated from equilibrium constants for dissociation of tungsten oxides. Permeation coefficients obtained in this manner had a temperature dependency in the range of 40 to 45 kcal/mole. (auth)

27494 (NYO–3454-6) THERMAL, STRUCTURAL, AND MAGNETIC STUDIES OF METALS AND INTERMETALLIC COMPOUNDS. Annual Report, May 15, 1965–May 15, 1966. Wallace, W. E.; Craig, R. S. (Pittsburgh Univ., Pa. Dept. of Chemistry). Contract AT(30-1)-3454. 96p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Magnetic characteristics (susceptibilities, magnetic ordering, temperatures and saturation magnetizations) were established for several compounds including: LnAl (with Ln = La, Ce, Pr, and Nd), LnAu (with Ln = Gd, Tb,

Dy, Ho, Er, Tm, and Yb) and for four alloy systems, Pr–Y, Pr–La, $TiCo_2$–$ZrCo_2$, and YFe_2–YCo_2. A variety of phenomena were observed, such as ferromagnetic and antiferromagnetic ordering that usually developed at low temperatures. Thermal capacity measurements were made on $MgCu_{2-x}Si_x$, β phase Ni–Al alloys, $TiFe_2$–$ZrFe_2$ alloys, $ZrCo_2$–$ZrFe_2$ alloys, $ZrFe_2$–YFe_2 alloys, and $MgCu_{2-x}Zn_x$. The nature of the coupling of the lanthanide moments was determined in 8 pseudo-binary systems of the form $Ln_{1-x}Ln'_xNi_z$ with z = 2 or 5. The coupling was found to be ferromagnetic when two heavy lanthanides were involved but antiferromagnetic when one heavy and one light lanthanide were present on the Ln-sublattice. Phase relationships were studied in the following pseudo-binary systems: $GdCo_2$–$GdAl_2$, $ErCo_2$–$ErAl_2$, $PrCo_2$–$PrAl_2$, $PrMn_2$–$ErMn_2$, $TiFe_2$–YFe_2, $ZrFe_2$–YFe_2, $TiFe_2$–$TiCo_2$, and $GdNi_2$–$GdAl_2$. The results indicate the frequent occurrence of intermediate phases which differ in structure from the terminal phases. A technique is presented for the measurement of internal friction at constant amplitude. There are advantages, which are pointed out in detail in the full description of this work, for working in this way. Equipment was built for growing single crystals of intermetallic compounds by the Bridgeman technique. (P.C.H.)

27495 (RFP–706) A STUDY OF THE EFFECTS OF ADDITIVES ON SINTERED TUNGSTEN POWDER COMPACTS. Williams, C. E.; Friebel, V. R. (Rocky Flats Div., Dow Chemical Co., Golden, Colo.). May 13, 1966. Contract AT(29-1)-1106. 27p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

The effects of uranium oxide, nickel, and palladium, additions on sintering and mechanical properties of isostatic-pressed tungsten powder compacts was investigated. A comparison was also made between slip casting and isostatic pressing for tungsten fabrication. Nickel and palladium lowered the sintering temperature, while uranium oxide increased the mechanical properties. The diametral-compression test for measuring relative tensile strengths was evaluated and used during the investigation. Electron fractography was used to study the fractures. (auth)

27496 (UCRL–14805) MECHANICAL PROPERTIES OF GAMMA-PHASE URANIUM–7.5 NIOBIUM–2.5 ZIRCONIUM ALLOY UNDER DYNAMIC LOADING. Hoge, K. G. (Lawrence Radiation Lab., Univ. of California, Livermore). Apr. 6, 1966. Contract W-7405-eng-48. 13p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

The effects of dynamic tension loading on the mechanical properties of gamma-phase U-7.5 wt% Nb-2.5 wt% Zr alloy are presented. Test data were taken at temperatures of 23, 200, 300, 400, and 500°C, at strain rates varying from 10^{-3} to 160 in./in.-sec. Tensile strength increased moderately with increasing strain rates, but more important was the fact that dynamic loading caused only a slight decrease in ductility. However, TTT curves for this alloy indicate that the gamma phase begins to transform to a cellular structure at temperatures slightly above 300°C in only a couple of minutes. At temperatures above 500°C it transforms into a pearlitic alpha-plus-gamma-2 structure. (auth)

27497 (WANL-PR-(Q)-009) DEVELOPMENT OF DISPERSION-STRENGTHENED TANTALUM-BASE ALLOY. Quarterly Progress Report No. 8, August 20–November 20, 1965. Buckman, R. W. Jr.; Goodspeed, R. C. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Contract NAS-3-2542. 37p. (NASA-CR–54935).

Development of dispersion strengthened tantalum base alloys for use in advanced space power systems continued with the processing of the side forged ingot of T-333 (Ta–8W–1Re–0.7Hf–0.025C) to sheet. Evaluation of this material is presently underway. Further phase identification and morphology work was performed, using optical and electron microscopy and x-ray and electron diffraction techniques. (auth)

27498 (WAPD-T–1757) HYDRIDE HABIT IN ZIRCONIUM AND IN UNSTRESSED AND STRESSED ZIRCALOY-4. Babyak, W. J. (Bettis Atomic Power Lab., West Mifflin, Pa.). June 1965. Contract AT(11-1)-Gen-14. 39p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

The habit planes for hydride precipitation in large grains of alpha zirconium and Zircaloy-4 were determined in specimens containing 161 and 136 ppM hydrogen, respectively. In zirconium, the hydride platelets precipitated on various pyramidal planes inclined to the basal plane at angles ranging from 10 to 50° and 75 to 90°. Hydrides were most frequent at inclinations of about 20 and 90°. In Zircaloy-4, the hydride habit was significantly different from that in zirconium. Hydride platelets were inclined to the basal plane at angles ranging from 5 to 25° with the predominant inclination equal to 12°; no platelets were found near the prism plane position. In both zirconium and Zircaloy-4, hydrides were principally, but not exclusively, parallel to $\{10\bar{1}1\}$ type planes. When the Zircaloy-4 grains were subjected to tension stresses of 12,100 psi and 19,400 psi during hydride precipitation, the hydride habit was essentially unchanged except that precipitation favored those habit planes that were more nearly perpendicular to the stress direction. The stress-orientation effect increased with the magnitude of the stress. (auth)

27499 (ORNL-tr–961) ON THE HIGH TEMPERATURE STRENGTH OF 18-8 Mo STAINLESS STEEL CASTINGS. Iwamoto, Kanetoshi; Kawabata, Masao; Fukase, Yukishige; Kato, Shoichi; Okubo, Nobuhiro. Translated for Oak Ridge National Lab., Tenn., from Zairyo (Japan), 14: 101-10(1965). 11p. Dep. mn. JCL $1.60 fs, $0.80 mf.

Type 316 and type 316L stainless steel-castings were subjected to high-temperature tensile tests, creep-rupture tests up to 10,000 hr at 650°C, aging treatments under various levels of stress at 650°C, and stress-free aging treatment up to 6,400 hr at 650°C, and the structural changes during these tests were observed in order to study the relations between the high-temperature properties and the structural changes of both alloys. Carbide and σ-phase were identified by the following means: the techniques of electrolytic etching by using concentrated strong hydroxide solutions (10N, KOH, to color the σ-phase, concentrated NH_4OH, to color the carbide); the x-ray diffraction analysis of the residues obtained by the electrolytic extraction with 10% HCl alcohol solution and $HOC_6H_2(NO_2)_3$ 5% HCl alcohol solution; distribution of Fe, Ni, and Cr in carbide and σ-phase decomposed from δ-ferrite, examined by x-ray microanalyzer; the short and long time high-temperature strength of type 316 is slightly superior to that of type 316L. The superiority of type 316 is attributed to the solid solution hardening effect of carbon and the more uniform distributions of fine carbide and σ-phase in the austenite matrix than in the case of type 316L. But the high-temperature long time load-carrying ability of both alloys seems to be fairly good. There was a little difference observed between type 316 and 316L in their structural changes during the tests, but they take place generally in the following sequences: The δ-ferrite decomposes into γ-phase, carbide and σ-phase; The carbide and σ-phase precipitate at austenite grain boundary; Carbide and σ-phase precipitate in austenite matrix; Decomposition of δ-ferrite and precipitation at austenite grain boundary are accomplished within 1,000 hr but the precipitation in austenite matrix gradually proceeds for a long time. Therefore, it is probable that the precipitation of fine carbide and σ-phase in austenite matrix influences mainly the long time high-temperature strength of these alloys, and that type 316 is a little superior in the high-temperature strength to type 316L, since the precipitates of fine carbide and σ-phase are dispersed uniformly in the austenite matrix of type 316, while the precipitation in the austenite matrix of type 316L is limited only around the regions which were formerly occupied by δ-ferrite. (auth)

27500 PROBLEMS IN THE FORMULATION OF THE DYSON SPIN-WAVE THEORY. Mills, Roger E.; Kenan, Richard P. (Battelle Memorial Inst., Columbus, Ohio). Ann. Phys. (N. Y.), 37: 104-12(Mar. 1966).

Formal problems are considered which arise when the Dyson spin-wave theory is used to calculate dynamical properties of magnetic systems. It is shown that the Dyson Hamiltonian correctly represents the operator

which generates infinitesimal time displacements in the system, that the Hamiltonian has real expectation values, and that the non-Hermiticity of the Hamiltonian is irrelevant to the physics of the problem. It is pointed out that algebraically correct operations on the boson operators can lead to unphysical results. The Bogoliubov transformation is suggested to be such a case unless the form of scalar products is simultaneously transformed. This difficulty is independent of the "kinematic interaction." (auth)

27501 CORRELATION BETWEEN MICROSTRUCTURE, CREEP AND HARDNESS OF ALLOYS OF THE SYSTEM TUNGSTEN CARBIDE (WC)–TITANIUM CARBIDE–COBALT. Dawihl, Walther; Frisch, Bertram. Arch. Eisenhuttenw., 36: 449-55(June 1965). (In German).

Measurements were made of compression strength and compression creep at room temperature and 1000 C using compression stresses of 12.5 kg/mm^2 for WC, TiC, and WC-TiC systems containing up to 25% Co. Hardness measurements were carried out at room temperature and related to the observed creep properties. Correlations between microstructure and the prevailing deformation mechanisms were evaluated and activation energies analyzed in special tests carried out from 550 to 1100°C. Results indicated that alloys containing Ti have better deformation resistance than corresponding W–Co alloys containing no Ti. These differences in the mechanical behavior were interpreted in terms of structural effects such as skeletons on TiC alloys. Analysis of the obtained activation energies indicated that at least two different deformation mechanisms act simultaneously. (Rev. Metal Lit.)

27502 CORRELATION BETWEEN THERMAL EXPANSION COEFFICIENT α AND GROWTH INDEX (GI). Kunchenko, V. V.; Roenko, N. M. At. Energ. (USSR), 20: 169-70(Feb. 1966). (In Russian).

The correlation between the thermal expansion coefficient, the texture, and the growth index (GI) of uranium crystals was investigated for temperatures between 25 and 100°C. The character of the texture and the degree of its manifestation were different and depended on the thermomechanical properties. (G.O.Y.)

27503 REACTIONS OF SAMARIUM AND GALLIUM TELLURIDES. Karaev, Z. Sh.; Gadymov, A. M.; Murguzov, M. I. Azerbaidzh. Khim. Zh., No. 4, 110-15(1965). (In Russian).

The reaction of samarium and gallium tellurides $A_2^{III}B_3^{VI}$ was investigated. It was established that in the system Sm_2Te_3–Ga_2Te_3 only one chemical compound, $SmGaTe_3$, is formed. The presence of limited solid solutions in the Ga_2Te_3- and Sm_2Te_3-rich areas of the system was detected. The alloys and compounds of the Sm_2Te_3–Ga_2Te_3 system have semiconductor properties. (tr-auth)

27504 BEHAVIOR REFERRED TO THE TRANSFORMATION OF UC_2 AT HIGH TEMPERATURES. Suzuki, Hiroshige; Kimura, Shiushichi. Bull. Tokyo Inst. Technol., No. 69, 49-54(1965).

The thermal expansion and contraction from 700–2300°C of the sintered UC_2 was measured and 2.1% of extraordinary volume change was found at about 1800°C. After the change was discussed on the basis of the result of x-ray diffraction and reflecting microscopic observation, the high temperature phase was found to be the cubic type of UC_{2-x}. And it is noted that this transformation should be noticed in the production and use of reactor fuel. (auth)

27505 HARDNESS OF ZIRCONIUM–OXYGEN ALLOYS. Dubertret, Alain; Lehr, Pierre (CNRS, Vitry-sur Seine, France). Compt. Rend., Ser. C, 262: 1147-54(Apr. 4, 1966). (In French).

The hardness of zirconium–oxygen solid solutions and of zirconia was measured for total system compositions up to 66 at. % oxygen. (tr-auth)

27506 HYDROGEN SOLUBILITY IN LIQUID NIOBIUM. Lakomskii, V. I.; Kalinyuk, N. N. (Electric Welding Inst., Academy of Sciences, Ukrainian SSR). Dokl. Akad. Nauk SSSR, 165: 1091-2(Dec. 11, 1965). (In Russian).

Small niobium specimens were levitation melted in a mixture of hydrogen, whose partial pressure was varied from 7 to 62 mm Hg, argon, and helium and brought to a temperature of 2873–2923, 2931–2965, 2982–3014, or 3073–3093°K. After the equilibrium between hydrogen in the gaseous phase and in liquid niobium had been established for a certain range of temperatures, the metal was cast in a copper mold. It was found that the solubility of hydrogen in liquid niobium depends on temperature. The dependence can be expressed by the equation $\lg S_{50} = 1620/T + 0.9993$, where S_{50} is the solubility of hydrogen in liquid niobium at a partial pressure of 50 mm Hg, and T is the absolute temperature (°K). The solubility of hydrogen in liquid niobium is higher than in solid niobium but in both cases it decreases with increasing temperature. The rate of this decrease in liquid niobium is lower than that in solid niobium. At the melting point the solubility changes abruptly. The calculated heat of dissolution of hydrogen in liquid niobium amounts to 14,800 cal per mol of hydrogen. (ATD)

27507 CHANGE IN THE FINE CRYSTALLINE STRUCTURE AND DEFORMATION RESISTANCE OF TUNGSTEN DURING ANNEALING. Smirnov, B. I.; Yakovlev, V. A. (Ioffe Inst. of Physics and Tech., Leningrad). Fiz. Metal. Metalloved., 21: 62-7(Jan. 1966). (In Russian).

The redistribution of microdistortions in individual regions of the crystal lattice during annealing of 99.99% pure W was investigated by blurring of x-ray lines as a criterion. Tungsten was selected because it facilitates comparison of the variation in microdistortions and in strength characteristics with increasing temperature. Specimens of W were preannealed in a vacuum for 90 min at 1600°C and subjected to the following operations: deformation by 7.5% reduction in area at 20°C, radiography, annealing for 90 min at various temperatures to 2000°C, radiography, and a second deformation, with determination of yield points at a deformation of 0.2% during the second loading. The fine crystalline structure of deformed W and its variation during annealing was determined according to the blurring of x-ray lines. The dimensions of microdistortions and blocks were determined both according to line width and by the method of harmonic analysis. The "effective" dimensions of the blocks in the directions [100] and [110] differed somewhat, while the microdistortions were the same. It was established that the variation in the microdistortions and yield points of specimens deformed at 20°C followed the same pattern in both cases. It was concluded that the anisotropy of "effective" block dimensions may be due to the presence of packing errors in the layers {112}. Microdistortions were the same in the directions [100] and [110] and attributable to the isotropy of the elastic properties of W and to the proper ratio between the densities of edge and screw dislocations. Both the microdistortions and the deformation resistance of the specimens were observed to decrease with increasing temperature. Depending on their nature, microdistortions may either contribute to or reduce the stressed state of the specimen. Microdistortions that change in polarity over distances of the order of the "path length" of dislocations impede the migration of dislocations, i.e., contribute to hardening of the metal, while residual microdistortions, resulting from residual stresses, which reverse polarity over much larger distances, contribute to local plastic flowage. (ATD)

27508 INTERACTION BETWEEN THE RELAXATION SPECTRUM AND HIGH-TEMPERATURE INTERNAL-FRICTION BACKGROUND OF REFRACTORY METALS. Aleksandrov, L. N.; Mordyuk, V. S. (All-Union Scientific Research Inst. of Light Sources, Saransk, USSR. Mordovskaya State Univ., USSR). Fiz. Metal. Metalloved., 21: 103-10(Jan. 1966). (In Russian).

The mobility of various defects causing internal friction in metals is limited by the energy of their interaction with the surrounding lattice, which depends on the general level of the bonding forces. The migration of defects is triggered by heat, and, therefore, in the presence of changes in the forces in the lattice (e.g., owing to alloying), the relaxation effects also are affected. Thus a definite relation

must exist between the relaxation spectrum and the background: if the background decreases, the relaxation maxima shift in the direction of high temperatures, and vice versa. The internal friction in recrystallized specimens of W and Mo wires treated with various combinations of Fe, Al, Si, and Ni was investigated in order to clarify the effect of treatment with alloy elements on relaxation characteristics. It was found that in the alloyed specimens, with their greater high-temperature strength and greater interatomic bonding forces the activation energy of the displacement of structural defects responsible for relaxation effects is higher. The defects creating the internal-friction background in the high-temperature region may lead to the appearance of a relaxation peak in the low-temperature region. For W the relaxation maximum was found to exist at 150°K; this maximum as well as the attendant background were both caused by the same relaxation mechanism, the diffusion of bivacancies in the field of the stresses applied (the activation energy of the relaxation process causing this maximum was estimated at 10 kcal/g atom, which is close to the activation energy of the movement of bivacancies, determined from the background at temperatures of 800 to 1600°C). (ATD)

27509 STUDY OF THE DIFFUSION OF CARBON IN β-ZIRCONIUM. Andrievskii, R. A.; Zagryazkin, V. N.; Meshcheryakov, G. Ya. (Moscow Inst. of Steel and Alloys). Fiz. Metal. Metalloved., 21: 140-3(Jan. 1966). (In Russian).

An emulsion of radioactive C was deposited on specimens at β-Zr that were then annealed at 1100 to 1600°C for 0.5 to 5 hr in a vacuum (10^{-4} to 10^{-5} mm Hg), with measurements of temperature by means of Pt-PtRh and W-WRe thermocouples. After annealing the C films were stripped off the specimens and the activities of the specimens were measured by means of a scaling unit with an end-window counter. The activation entropy ΔS of the diffusion of C in β-Zr was calculated at 4.95 cal/mole-deg. The activation energy Q was found to be linearly dependent on the atomic radius of the element (Q = 34.2 kcal/mole for C), and the ΔS/Q ratio was found to be constant for the diffusion of various interstitial impurity elements (H, O, and N) into the same metal; other metals with bcc lattices, such as α-Fe or Ta are also governed by these laws. It is characteristic that the radius corresponding to "zero" activation energy is ~0.25 Å, which satisfactorily tallies with the radius of octahedral pores in β-Zr (r_{oct} = 0.243 Å). (ATD)

27510 INVESTIGATION OF EXTRUDED TUNGSTEN COMPOSITES CONTAINING FIBERED OR REACTED ADDITIVES. II. ANALYSIS OF DATA. Quatinetz, Max; Weeton, John W.; Herbell, Thomas P. (Lewis Research Center, Cleveland). Int. J. Powder Met., 2: No. 2, 51-64 (Apr. 1966).

Examination of transverse and longitudinal sections of extruded materials showed that some degree of fibering was achieved with all of the additives (zirconia, yttria, hafnia, thoria, as well as hafnium boride, hafnium nitride, hafnium carbide, and tantalum carbide). The extent of the elongation varied with the degree of deformation throughout the extruded bar, and was greater at the middle than at the nose of the bar, and greater at the edges than at the middle. (auth)

27511 EFFECT OF WC IMPURITY ON SHORT-RANGE PHASE SEPARATION IN A TaC–NbC SOLID SOLUTIONS. Umanskii, Ya. S.; Fadeeva, V. I. (Inst. of Steel and Alloys, Moscow). Izv. Akad. Nauk SSSR, Neorg. Mater., 2: 82-6(Jan. 1966). (In Russian).

The effects of small amounts of a third metallic component (W) on short-range order in the (Ta, Nb)C solid solution and on the kinetics of its establishment as compared to an unalloyed solid solution were studied. One mole % of WC was dissolved in a TaC-NbC solid solution of stoichiometric composition. The intensity distribution of diffuse x-ray scattering caused by the short-range order was determined with a URS-501 diffractometer. The small amount of WC introduced was found to cause local distortions in the alloy, promoting an increase in the diffusional mobility of tantalum and niobium atoms. Calculation of the energies of mixing (U) of the solid solutions, carried out by using short-range order coefficients α_1, showed that the short-range order observed was an equilibrium one. Measurement of the microhardness, which increased in the presence of WC, also confirmed the presence of short-range order. (ATD)

27512 PHASE EQUILIBRIA IN ALUMINUM-RICH ALLOYS OF THE Ce–Al–Sb SYSTEM. Zarechnyuk, O. S.; Tsygulya, E. A. (Lvov State Univ.). Izv. Akad. Nauk SSSR, Neorg. Mater., 2: 210-11(Jan. 1966). (In Russian).

X-ray analyses were made of three binary and six ternary alloys of the Ce-Al-Sb system; compositions of binary alloys corresponded to the binary compounds CeSb, AlSb, and $CeAl_4$, and those of ternary alloys were located on the AlSb-$CeAl_4$ section, which joins the aluminum-rich compounds of Al-Sb and Ce-Al systems. Heat treatment of the alloys consisted in annealing for 150 hr at 500°C with quenching in toluene. Measurements showed that the alloy of composition $Ce_{14}Al_{72}Sb_{14}$ consisted of two phases: its x-ray powder pattern contained lines of the compound SeSb and of Al. Alloys with an Sb content greater than 14 at. % consisted of three phases: Al, AlSb, and CeSb. Alloys with Sb contents below 14 at. % also consisted of three phases: Al, $CeAl_4$, and CeSb. The existence of the ternary equilibria Al + AlSb + CeSb and Al + $CeAl_4$ + CeSb in the Ce-Al-Sb system indicated that the binary compounds AlSb and $CeAl_4$ were also in equilibrium with CeSb. It was concluded that the Ce-Al-Sb system differs from Ce-Cu-Al, Ce-Mn-Al, and Ce-Si-Al systems in that it does not have a ternary compound in equilibrium with an aluminum solid solution and has some features in common with the Ce-Be-Al system. (ATD)

27513 PRELIMINARY OBSERVATIONS ON THE CREEP FRACTURE OF ALPHA URANIUM. Taplin, D. M. R. (Univ. of Melbourne). J. Brit. Nucl. Energy Soc., 5: 153-5(Apr. 1966).

The mode of creep fracture of reactor grade uranium has been investigated between 300-520°C at a stress of 2.8 kg. mm^{-2}. At 300°C creep ductility is high while at 420°C a brittle intercrystalline fracture associated with the formation of wedge shaped cavities at grain corners is exhibited. A more ductile behavior is again observed at 520°C: voids form at grain boundaries, but these grow in a direction parallel to the tensile axis rather than propagating transversely; failure then ensues by gradual cavity coalescence. These results are correlated with the "swelling" of uranium under reactor operating conditions. (auth)

27514 GEOMETRIC CONDITIONS OF FORMATION OF TWINS BY PULLING OR BY COMPRESSION. APPLICATION TO THE CASE OF α URANIUM. Calais, D.; Jaoul, B.; Lacombe, P. (Ecole Nationale Superieure des Mines, Paris). J. Nucl. Mater., 10: 181-6(May 1966). (In French).

A theoretical study is made of the geometric conditions for the formation of twins by pulling or compression of α-uranium. The results obtained are valid only in the first stages of deformation. It was shown that the pulling axes should be located in the dihedron limited by the K_1 and P planes and contain the K_2' plane. The compression axes should be placed in the dihedron limited by the K_1 and P planes and contain the K_2 plane. (J.S.R.)

27515 TITANIUM FILAMENTS FOR SUBLIMATION PUMPS. McCracken, G. M.; Pashley, N. A. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). J. Vac. Sci. Technol., 3: 96-8(May-June 1965).

The performance of an alloy of 85% Ti 15% Mo as a filament material for subliming titanium in getter pumps is described. Using 2.1-mm-diam filaments, evaporation rates of up to 1 mg/cm/min were achieved at filament currents of 57 amp. The upper limit in the evaporation rate is caused by filament failure which is attributed to crystal growth, but at values below this limit the evaporation is extremely uniform and reproducible. Comparison was made between the performance of this alloy and a number of filaments of the type in which titanium is wrapped over a tungsten or tantalum core. The alloy was found to compare favorably in terms of peak evaporation rate and ef-

ficiency, and to be considerably better in terms of expense, reproducibility, and mechanical strength. (auth)

27516 VAPOR DEPOSITED GOLD THIN FILMS AS LUBRICANTS IN VACUUM (10^{-11} mm Hg). Spalvins, T.; Buckley, D. H. (Lewis Research Center, Cleveland). J. Vac. Sci. Technol., 3: 107-13(May-June 1965).

Gold thin films of 1800 Å to be used as lubricants were vapor deposited on Ni, Ni–Cr, and Ni–Re substrates. Strong bonding (adhesion) and durability between the film and substrate were found to be essential when thin films are used as a lubricant. Factors that were investigated included the selection of the film and substrate material. Strong durability of the this film is directly related to the type and structure of the interfacial region. Two methods of substrate preparation prior to vapor deposition were investigated: mechanically polished surface and electron bombarded surface. Gold was vapor deposited on the mechanically polished surface at room temperature and on the thermally etched surface at an elevated temperature approximately (800°F). Strength and durability of the films were investigated in sliding friction experiments with a hemispherical niobium rider sliding on the films at a velocity of 5 ft/min. Results obtained in these friction experiments indicated that the film endurance life was considerably better on the thermally etched surface. This increased film durability with the thermally etched surface is believed to be owing to the formation of a diffusion type interface between the film and the substrate. Because of the disregistry at grain boundaries, a higher rate of diffusion and preferential trapping in and around the grain boundaries occurs, with these regions acting as lubricant reservoirs during the friction experiments. (auth)

27517 ADSORPTION OF RUTHENIUM ON SOLID SORBENTS IN ACID AQUEOUS SOLUTIONS. Pelcik, Jiri; Bar, Jaromir (Vojenska Akademie A. Zapotockeho, Brno). Jad. Energ., 12: 126-9(1966). (In Czech).

The adsorption kinetics of ruthenium were investigated. The adsorptive factors of ruthenium were established for solutions of 0.1 M hydrochloric acid and in acetate buffered solutions at pH 5.5 of ruthenium nitrosonitrate on the surface of teflon, glass, polyvinyl chloride, polyethylene, paper, rubber, activated charcoal, and wool for ruthenium concentrations of 0.084 and 0.0084 g-at/l. (tr-auth)

27518 STUDY OF THE DIFFUSION OF FISSION GASES IN METALS. Perraillon, B.; Levy, V.; Adda, Y. (Commissariat a l'Energie Atomique, Saclay, Gif-sur-Yvette, France). Mem. Sci. Rev. Met., 63: 227-36(Mar. 1966). (In French).

The diffusion coefficient of ^{133}Xe in uranium was determined. There is a discontinuity of the diffusion coefficient at the $\beta \rightarrow \gamma$ transition point and this is indicated by a decrease of the coefficient and an increase of the activation energy of the phenomena. (tr-auth)

27519 CONTRIBUTION TO THE STUDY OF LOW-CHARGE URANIUM ALLOYS. Colombie, M.; Foure, M. (CERCA, Bonneuil-sur-Marne, France). Mem. Sci. Rev. Met., 63: 253-69(Mar. 1966). (In French).

Three $\beta \rightarrow \alpha$ transformation processes were detected in uranium alloys containing Cr, Si, Ge, and Zr. At high temperatures the transformation mechanism is of the nucleation and growth type. At lower temperatures a decomposition mechanism intervenes, probably of the bainitic type. Below 400°C the transformation occurs by shear without diffusion. (tr-auth)

27520 THERMOELASTIC STRESSES AND DEFORMATIONS IN REACTOR FUEL PLATES. Youngdahl, Carl K. (Argonne National Lab., Ill.). Nucl. Eng. Design, 3: 205-22(1966).

The thermoelastic stresses and displacements in a reactor fuel plate are determined for arbitrary temperature distributions and normal-surface tractions which do not vary across the width of the plate and are symmetrical about the mid-plane of the thickness. It is assumed that cross sections perpendicular to the width dimension are in a state of plane strain. The exact solution involving no thin plate approximations is obtained through the use of the Papkovich stress functions and Fourier series methods. The determination of the coefficients of the resulting series for the stresses and displacements requires the numerical solution of infinite sets of simultaneous linear algebraic equations. Two approximate solutions based on small thickness-to-length ratios are derived; quantitative estimates of the errors involved in these approximate solutions are obtained by comparison with the exact solution. (auth)

27521 A STUDY OF THE ENERGY CRITERION FOR FATIGUE. Stowell, E. Z. (Southwest Research Inst., San Antonio). Nucl. Eng. Design, 3: 32-40(Jan. 1966).

On the assumption that fatigue is caused by the gradual accumulation of small amounts of hysteresis energy, and that failure will occur when the total amount of energy accumulated is equal to the energy required for fracture as determined by static tests, an attempt was made to compute the fatigue curve using only the information obtained from static tests. The results were compared with the fatigue data for 12 materials. These data were obtained by strain cycling about zero-mean strain. Comparison shows that the theory will duplicate the data reasonably well, provided the original material is not in a "soft" or annealed condition. This restriction is necessary because the material hardens during cycling and so the stress-strain curve obtained from the original material is not representative of the material during cycling. If the original material is in a hardened state, the theory will give good results. The modified Coffin formula gives results which are, in most cases, overly conservative. (auth)

27522 TRANSIENT DETERMINATION OF THERMAL PROPERTIES. Beck, J. V. (Michigan State Univ., East Lansing). Nucl. Eng. Design, 3: 373-81(Apr. 1966).

A powerful statistical procedure called nonlinear estimation can be used to simultaneously determine several properties appearing in certain partial differential equations if appropriate measurements are made. These properties might include a number of those of particular interest in nuclear engineering. The method is illustrated, however, for the determination of thermal conductivity and specific heat given transient temperature measurements. The properties are found by making the calculated temperatures match the measured temperatures in a least-squares sense. The method utilizes finite-differences for the solution of the heat-conduction equation and for minimizing a sum of squares function: the method is well adapted for use with a digital computer. Certain experiments are discussed for which the thermal properties can be accurately determined. The use of the method to calculate thermal properties from exact and experimental data is described. (auth)

27523 LEAD CONCRETE—FIRST EXTRA-HIGH-DENSITY SHIELDING SUITABLE FOR INSTALLATION BY MASS PRODUCTION METHODS. Hall, Wm. Cornelius (Chemtree Corp., Central Valley, N. Y.). Nucl. Eng. Design, 3: 476-7(Apr. 1966).

A new lead concrete material is described. It has a density approaching solid lead, is completely formable, can be installed easily in volume, and was formulated for use as shielding against photon radiations. This material has a density much greater than densified concretes, approximately the same relative attenuation efficiency as lead for photons on a mass basis; it can be poured or cast, is bondable to most structural materials, withstands exposure to mild acids or alkalis, and apparently will tolerate temperatures from −20 to 600°F. (J.F.P.)

27524 ROLE OF DEFECTS ON THE MECHANICAL PROPERTIES OF NONFISSIONABLE CERAMICS. Stokes R. J. (Honeywell Research Center, Hopkins, Minn. Carnegie Inst. of Tech., Pittsburgh). pp 3-29 of Nuclear Applications of Nonfissionable Ceramics. Boltax, Alvin; Handwerk, J. H. (eds.). Hinsdale, Ill., American Nuclear Society, 1966.

The nature of point, line, and surface defects in ceramics is discussed. The interactions between these defects and their role in the various modes of mechanical deformation are reviewed. Anelastic effects, plastic yielding, brittle

and ductile fracture, and creep in single-crystal and polycrystalline ceramics are described. Emphasis is on the behavior of ideal, well-characterized materials of high purity and zero porosity. (auth)

27525 FACTORS AFFECTING STRENGTH AND FRACTURE OF NONFISSIONABLE CERAMIC OXIDES. Parikh, N. M. (Illinois Inst. of Tech., Chicago). pp 31-56 of Nuclear Applications of Nonfissionable Ceramics. Boltax, Alvin; Handwerk, J. H. (eds.). Hinsdale, Ill., American Nuclear Society, 1966.

The basic factors affecting strength and fracture of ceramic oxides are reviewed and particular emphasis on polycrystalline Al_2O_3. Statistical treatment of strength, although useful, is shown to provide little insight into the fracture behavior. Relevant aspects of brittle fracture and crack nucleation and propagation are discussed, and possible fracture mechanisms are presented. These are reviewed in relation to fracture energy measurements. Influence of temperature, grain size, porosity, surface condition, and stress state on strength and fracture are discussed in the context of recent experimental evidence. (auth)

27526 MECHANICAL PROPERTIES OF REFRACTORY CARBIDES AT HIGH TEMPERATURES. Steinitz, Robert (General Telephone and Electronics Labs., Inc., Bayside, N. Y.). pp 75-100 of Nuclear Applications of Nonfissionable Ceramics. Boltax, Alvin; Handwerk, J. H. (eds.). Hinsdale, Ill., American Nuclear Society, 1966.

A critical review of mechanical property data for carbides is presented. The reasons for the wide divergence of the values for the individual carbides are discussed, and it was concluded that few data are useful as a basis for an understanding of the deformation mechanisms. Creep measurements on tantalum carbide are reported, which show the large dependence of all mechanical properties on the carbon-to-metal ratio. An evaluation of data on TiC and TaC showed that the carbides can essentially be regarded as modifications of the base metal with interstitial carbon. The creep behavior of polycrystalline material at high temperature is controlled by the diffusion rate of the metal, since the activation energies for creep and diffusion are the same. While TiC softens with lower carbon content, TaC becomes harder and its creep rate decreases rapidly. Possible explanations for deformation mechanism and strengthening by carbon vacancies are discussed. (auth)

27527 DIFFUSION-CONTROLLED DEFORMATION AND SHAPE CHANGES IN NONFISSIONABLE CERAMICS. Chang, R. (North American Aviation Science Center, Thousand Oaks, Calif.). pp 101-12 of Nuclear Applications of Nonfissionable Ceramics. Boltax, Alvin; Handwerk, J. H. (eds.). Hinsdale, Ill., American Nuclear Society, 1966.

Some recent creep, sintering, and grain-boundary grooving experiments on aluminum oxide, beryllium oxide, and magnesium oxide were analyzed in terms of concurrent surface, grain boundary, and lattice diffusion-controlled mechanisms. The analysis yielded lattice-diffusion coefficients, which are in reasonably good agreement with those measured directly by means of cation-tracer diffusion experiments. The surface and grain-boundary diffusion coefficients fell within a narrow range for all three oxides, and suggest a common diffusion species, the oxygen ions. (auth)

27528 PROPERTIES OF CERAMIC COMPOSITES CONTAINING FIBROUS REINFORCEMENTS. Corbett, W. J.; Walton, J. D. Jr. (Georgia Inst. of Tech., Atlanta). pp 113-29 of Nuclear Applications of Nonfissionable Ceramics. Boltax, Alvin; Handwerk, J. H. (eds.). Hinsdale, Ill., American Nuclear Society, 1966.

The properties and behavior of a ceramic as the matrix in a fiber-reinforced composite are discussed. Particular attention was given to the load transfer mechanism available in ceramic matrices. Unlike the more ductile matrices, polymers and metals, matrix elongation for load transfer to the fibrous reinforcement is not available in ceramics, but such transfer may be accomplished by prestressing the structure during fabrication. Methods of fabricating ceramic composites containing fibrous reinforcements, such as hot pressing, slip-casting, and impregnation, are discussed. The properties of various ceramic composites containing metal fibers, inorganic fibers, and single-crystal whiskers, are presented. Attention is drawn to the fact that in the case of a ceramic matrix, the incorporation of fibers may produce significant improvements in such properties as toughness and thermal-shock resistance as well as in load-bearing capability. (auth)

27529 BERYLLIUM OXIDE: REVIEW OF PROPERTIES FOR NUCLEAR REACTOR APPLICATIONS. Simnad, M. T.; Meyer, R. A.; Zumwalt, L. R. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). pp 169-228 of Nuclear Applications of Nonfissionable Ceramics. Boltax, Alvin; Handwerk, J. H. (eds.). Hinsdale, Ill., American Nuclear Society, 1966.

The behavior of beryllium oxide in nuclear reactor applications is reviewed. Beryllium oxide was used as a moderator and also as a matrix material in dispersion-type fuel bodies. Effects of irradiation on physical and mechanical properties of BeO are governed by a large number of variables, such as structure, grain size, density, and purity of the material, as well as the temperature of irradiation and neutron dose, energy, and flux. The mechanism of irradiation damage is related to the anisotropic growth of the grains at low temperatures and to formation of helium and fission gas bubbles at elevated temperatures. Recent studies included measurements of radiation effects on physical and mechanical properties, stored energy, and diffusion of Be, lithium, and fission gases in irradiated beryllium oxide. (147 references). (auth)

27530 CARBON DIFFUSION IN THE GROUP IVB AND VB TRANSITION ELEMENT MONOCARBIDES. Tobin, J. M.; Adelsberg, L. M.; Cadoff, L. H.; Brizes, W. F. (Westinghouse Astronuclear Lab., Pittsburgh). pp 257-77 of Nuclear Applications of Nonfissionable Ceramics. Boltax, Alvin; Handwerk, J. H. (eds.). Hinsdale, Ill., American Nuclear Society, 1966.

Published data on the diffusion of carbon in transition element monocarbides were critically reviewed. Data are summarized for the diffusion of carbon in titanium, zirconium, hafnium, vanadium, niobium, and tantalum monocarbides, which were measured over temperature ranges overlapping between 1700 and 3000°C by the layer-growth method. The observed parabolic layer-growth kinetic behavior results from the chemical diffusion of carbon in the carbide phases. An atomic jump mechanism and a general theory of diffusion in the B1 crystal structure monocarbides are proposed. (auth)

27531 INSULATORS FOR THERMIONIC ENERGY CONVERTER APPLICATION. Grossman, L. N.; Kaznoff, A. I. (Vallecitos Atomic Lab., Pleasanton, Calif.). pp 421-33 of Nuclear Applications of Nonfissionable Ceramics. Boltax, Alvin; Handwerk, J. H. (eds.). Hinsdale, Ill., American Nuclear Society, 1966.

Alumina insulators are widely used for nuclear thermionic application because of their adequate properties and the advanced state of alumina fabrication. Limitations were encountered at moderate temperatures resulting from Al_2O_3–Nb interaction. The weight loss rate of alumina was increased about a hundredfold when in contact with niobium. Equilibrium (Knudsen cell) studies of the Al_2O_3–Nb reaction are presented as are typical interfacial reaction microstructures. Yttria is suggested as an alternative insulator for high-temperature use in contact with niobium. No solid state reaction products exist between the refractory oxides and W, Mo, or Re at temperatures up to 2000°C. The degradation of mechanical and physical properties of insulators due to radiation is discussed. Photoconductivity resulting from the radiation field is present in power reactors but is insufficient to be detrimental to insulator performance. (auth)

27532 NUCLEAR POISONS AND CONTROL APPLICATIONS OF CERAMIC MATERIALS. Leitten, Carl Fredrick Jr. (Oak Ridge National Lab., Tenn.). pp 435-51 of Nuclear Applications of Nonfissionable Ceramics. Boltax, Alvin; Handwerk, J. H. (eds.). Hinsdale, Ill., American Nuclear Society, 1966.

Recent economic trends in reactor development programs to use long-life fuel cores operating at higher power densities impose acute problems on the selection and performance of the nuclear control system. For this reason, ceramic-base compounds are being used in reactors, both in bulk form and as dispersoids in various metal-base alloys. Advances in developing ceramic-base materials with improved chemical and physical properties for neutron-absorbing material applications. Emphasis is placed on the development of hydration-resistant compounds of the lanthanides, their methods of preparation, physical and chemical properties, and irradiation stability. In addition, the use of boron-bearing ceramics, particularly as glasses, is reviewed in regard to their properties and irradiation stability. Methods are described for fabricating boron-bearing compounds and shapes with varying boron concentrations to achieve uniform burnup characteristics throughout the absorber. (auth)

27533 PROSPECT FOR RATIONAL DESIGN OF CERAMIC STRUCTURAL COMPONENTS. Rudnick, A.; Duckworth, W. H. (Battelle Memorial Inst., Columbus, Ohio). pp 453-69 of Nuclear Applications of Nonfissionable Ceramics. Boltax, Alvin; Handwerk, J. H. (eds.). Hinsdale, Ill., American Nuclear Society, 1966.

Conventional structural-design procedures are inadequate in many respects for application to ceramics and other brittle materials. In particular, more rigorous load and stress analyses are required, and new concepts must be employed to specify allowable stresses. The major problems in load and stress analyses stem from the necessity to carefully consider all possible stress concentrations. Allowable stresses in a design are difficult to specify because of considerable scatter in strength values, and an apparent dependence of strength on specimen size and stress distribution. With a view to indicating the present status in the development of a structural-design technology for brittle materials, the sources of pertinent difficulties and progress in developing methods for treating them are discussed. (auth)

27534 REMARKS ON THE DEKKER THEORY OF ELECTRICAL RESISTIVITY OF THE RARE EARTH ALLOYS. Chen, C. W.; Ashkin, M.; Takei, W. J. (Westinghouse Electric Corp., Pittsburgh). Contract AF 49(638)-1245. Phys. Lett., 21: 243-5(May 15, 1966).

The inapplicability of the Dekker theory to the ferromagnetic alloys of lanthanides containing light rare earth solutes is discussed in relation to the mode of spin coupling and the ground-state energy levels of the solute ions. (auth)

27535 STRUCTURE FACTOR FOR LIQUID METALS AT LOW ANGLES. Egelstaff, P. A. (Atomic Energy Research Establishment, Harwell, Eng.); Duffill, C.; Rainey, V.; Enderby, J. E.; North, D. M. Phys. Lett., 21: 286-8 (May 15, 1966).

Neutron scattering measurements are reported of the structure factor S(Q) in the region $0.2 < Q < 1.6$ Å^{-1} for liquid Pb, Sn, Bi, Tl, Zn and Al. (auth)

27536 HEAT CAPACITY OF BERYLLIUM BELOW 30 DEG K. Ahlers, Guenter (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 145: 419-23(May 13, 1966).

The heat capacity of high-purity beryllium ($R_{300}/R_{4.2}$ = 1100) was measured from 1.4 to 30°K. The results can be expressed by the sum of contributions proportional to T, T^3, and T^5 with the coefficients (0.1714 ± 0.0008) mJ/M (°K)^2, (0.598 ± 0.020) × 10^{-3} mJ/M (°K)^4, and (0.18 ± 0.04) × 10^{-6} mJ/M (°K)^6, respectively. The Debye theta at 0°K (Θ_0) is (1481 ± 16)°K. The results are in good agreement with some of the recent lattice-dynamical and band-structure calculations and with Θ_0 derived from elastic constants. Phonon enhancement of the density of states does not appear important in beryllium. The heat capacity is smaller than the work of previous investigators indicated. (auth)

27537 METHOD FOR DETERMINING SILICON DIFFUSION COEFFICIENTS IN SILICON AND IN SOME SILICON COMPOUNDS. Ghoshtagore, R. N. (Xerox Corp., Webster, N. Y.). Phys. Rev. Lett., 16: 890-2 (May 16, 1966).

A method which is an extension of the isotope-dilution method suggested by Ryskin (Soviet Phys-Solid State 1; 870(1959)) in combination with a chemical sectioning technique used by Abe and Sato (Japan J. Applied Phys. 4: 70 (1965)) is utilized for determining silicon diffusion coefficients. (B.G.D.)

27538 MOLYBDENUM AND MOLYBDENUM ALLOYS. Malinsky, I.; Zeman, K. Pokroky Prask. Met., No. 3, 39-59(1963). (In Czech).

The physical, mechanical, and corrosion properties of Mo and Mo alloys, processing of semifinished Mo products (sintering, melting), machining, welding, and soldering, and possible uses are discussed. Due to the extremely low oxidation resistance of Mo in a gaseous medium at 600°C, consideration was given to a search for methods of protecting the surface of Mo. When processing semifinished Mo products, indirect sintering in H_2, which consists of compacting Mo powders and sintering for prolonged periods in furnaces at 1600 to 1800°C, making it possible to prepare articles weighing up to 400 kg, was found to be most effective. The workability of Mo can be compared with the workability of gray cast iron. A fibrous structure and a hardness within limits of 200 to 250 H_B are the optimum conditions for working. Mo may be subjected to grinding, honing, electric spark machining, electron beam drilling, and electrolytic microtreatment. (Rev. Metal Lit.)

27539 INVESTIGATION OF THE EFFECT OF THE TEMPERATURE OF OBTAINING TUNGSTEN CARBIDE ON THE FORMATION OF HARD ALLOYS WITH NONUNIFORM DISTRIBUTION OF THE CARBIDE PHASE. [PART] II. Krushinskii, A. N. (Kiev Polytechnic Inst.). Porosh. Met., Akad. Nauk Ukr. SSR, No. 4, 16-20(Apr. 1966). (In Russian).

The effects of the temperature in the preparation of WC on the formation of hard phases were studied. The change in WC properties was found to depend on its temperature of preparation (1400 to 1800°C). It is shown on a series of hard phases that a rise in temperature improves the structure and properties of systems with nonuniform distribution of the carbide phase. (auth)

27540 ISOTHERMAL SECTIONS OF THE SYSTEM MOLYBDENUM–IRON–BORON. Gladyshevskii, E. I.; Fedorov, T. F.; Kuzma, Y. B.; Skolozdra, R. V. (Lvov State Univ. Baikov Inst. of Metallurgy, USSR). Porosh. Met., Akad. Nauk Ukr. SSR, No. 4, 55-60(Apr. 1966). (In Russian).

The system Mo–Fe–B was investigated by means of x ray and microscopic analyses. The phase equilibria were established at 1000°C. The ternary compound Mo_2FeB_2 exists in the range from 20 to 28 at. % Fe and has a superstructure of the U_3Si_2 type (a = 5.807 to 5.729 ± 0.004 and c = 3.142 to 3.151 ± 0.003 Å). The ternary compound (Mo, Fe)B has a structure of the CrB-type (the lattice constants are similar to those of the high-temperature modification of MoB). The compound $MoFe_2B_4$ has a superstructure of the the Ta_3B_4 type (a = 3.128 ± 0.005, b = 12.70 ± 0.01, and c = 2.984 ± 0.005 Å). (auth)

27541 TRIANGULATION OF THE SYSTEM C–Si–Be. Matyushenko, N. N.; Rosen, A. A.; Pugachov, N. S. (Inst. of Physics and Tech., Khar'kov). Porosh. Met., Akad. Nauk Ukr. SSR, No. 4, 61-4(Apr. 1966). (In Russian).

The triple system C–Si–Be was triangulated by studying the interaction between carborundum and beryllium. The interaction product is a mixture of silicon and beryllium carbide (CBe_2). The polythermal sections Si–CBe_2 and CBe_2–SiC are quasibinary systems. There is no liquid eutectic in system Si–CBe_2 close to 1400°C. (auth)

27542 SOLUBILITY OF DISILICIDES OF TRANSITION METALS IN MoSi AND WSi_2. Verkhoglyadova, T. S.; Vivchar, O. I.; Gladyshevskii, E. I. (Inst. of Problems in Material Studying, Academy of Sciences, Ukrainian SSR, Lvov State Univ.). Porosh. Met., Akad. Nauk Ukr. SSR, No. 4, 69-72(Apr. 1966). (In Russian).

By means of x-ray and microstructural methods the existence of a continuous solid solution in the system $MoSi_2-ReSi_2$ was confirmed and unlimited reciprocal solubility of disilicides in the systems WSi_2-ReSi_2 and $MoSi_2-WSi_2-ReSi_2$ was found. Limited solid solutions were formed in the ternary systems $MoSi_2-WSi_2-MeSi_2$ (where Me = Ti, V, Nb, Ta, or Cr). (auth)

27543 GLIDE LINES IN CARBIDE CRYSTALS. Benesovsky, Friedrich; Ihrenberger, Albin (Metallwerk Plansee, Reutte, Tirol, Austria). Prakt. Metallog., 3: 126-7(Apr. 1966). (In German).

Slip bands were detected in deformed tungsten single crystals of approximately 100 to 200 μm size. The crystals were deformed during cooling. The direction of the effective slip system in the $[\bar{1}100]$ is shown. (tr-auth)

27544 STUDY OF DENSITY AND STRUCTURE OF URANIUM OXIDES IN THE COMPOSITION RANGE $UO_3-U_3O_8$. Strekalovskii, V. N.; Beketov, A. R.; Vlasov, V. G. Tr. Inst. Elektrokhim., Akad. Nauk SSSR, Ural. Filial, No. 6, 131-6(1965). (In Russian).

Research was carried out with the alpha and gamma forms of UO_3 dissociated in vacuum. X-ray data and density measurements determined by vacuum pycnometry revealed the relationship between density and structure of the products in the $UO_3-UO_{2.67}$ system. Parameters were calculated of hexagonal unit cells of solid solutions in the alpha $UO_3-UO_{2.9}$ range and of orthorhombic structures in the $UO_{2.2}-UO_{2.67}$ range. Defects typical of both the oxygen and uranium sublattices characterize the orthorhombic solid solution formed in the $UO_{2.9}-UO_{2.67}$ range. (Rev. Metal Lit.)

27545 AN EVALUATION OF THE CREEP PROPERTIES OF Cb-753 AND A COMPARISON OF THIS ALLOY WITH SEVERAL OTHER NIOBIUM-BASE ALLOYS. McCoy, H. E. (Oak Ridge National Lab., Tenn.). Trans. Amer. Soc. Metals, 59: 277-87(1966). (ORNL-TM-1347).

The creep properties of the refractory alloy, Cb-753(Nb-5% V-1.25% Zr), were evaluated at 982 and 1204°C. The alloy recrystallized during testing at 982°C at stresses that produced rupture lives of over 100 hr. At 1204°C recrystallization and grain growth during testing were both observed. Moderate improvements were made in the creep properties by pretest annealing at temperatures up to 1900°C. The fracture ductility of the alloy was quite good; the minimum fracture elongation observed under any test conditions was 40%. A comparison was made of the strengths of the Cb-753 alloy with those of several other niobium-base alloys, Nb-1% Zr, D-43, and B-66. At 982°C the Cb-753 alloy was competitive for applications of less than 80 hr duration. For longer periods the order of strengths from greatest to least was D-43, Cb-753, B-66, and Nb-1% Zr. At 1204°C the order of strengths from greatest to least was D-43, B-66, Cb-753, and Nb-1% Zr. However, the alloys containing vanadium, B-66 and Cb-753, exhibited creep-rupture curves with very high slopes. This deterioration of the allowable stress for long-service lives is felt to be explained by the observation that vanadium additions to niobium reduce the melting point and increase the rate of self-diffusion. (auth)

27546 PARTIAL CONSTITUTIONAL DIAGRAMS FOR THE Cd-La, Cd-Ce, Cd-Pr, Cd-Nd, AND Cd-Sm SYSTEMS. Johnson, Irving; Anderson, Karl E.; Blomquist, Robert A. Trans. Amer. Soc. Metals, 59: 352-5(1966).

Partial constitutional diagrams of the cadmium-rich portions of the binary Cd-Ce, Cd-La, Cd-Nd, Cd-Pr, and Cd-Sm systems were determined in a study of the thermodynamic properties of cadmium-rich lanthanon alloys. The low-temperature portions of the liquidus were determined by measuring the solubilities of the lanthanon metals in liquid calcium. The solubilities were measured by chemical analysis of filtered samples of the equilibrium liquid phase. Liquidus compositions between the highest solubility points and the peritectic points were computed by extrapolation of the solubility data using empirical equations of the form, log (at. % Ln) = $a - bT^{-1}$. The trend in solubilities and peritectic temperatures of the $LnCd_{11}$ compounds with increasing atomic number is a result of the decreasing stability of the $LnCd_{11}$ compounds with decreasing size of the lanthanon metal atom. (F.J.H.)

27547 INTERMETALLIC DIFFUSION IN URANIUM-ALUMINIUM SYSTEM. Nayar, P. K. K. Trans. Indian Inst. Metals, 18: 51-5(Mar. 1965).

Intermetallic diffusion in the U-Al system was investigated from 350 to 600°C by making sandwich type couples employing metallographic and autoradiographic techniques. The growth kinetics of various phases and their relative distribution in the diffusion zone varied with the temperature of the diffusion-anneal. Interdiffusion introduced structural defects in the diffusion zone and affected the geometry of the couple itself. (Rev. Metal Lit.)

27548 CHANGES OF DISLOCATION DAMPING OBSERVED DURING YIELDING OF MAGNESIUM, MOLYBDENUM, AND LiF. Koss, D. A.; Gordon, R. B. (Yale Univ., New Haven). Trans. Met. Soc. AIME, 236: 658-63 (May 1966).

Ultrasonic-attenuation changes due to formation of free dislocations were observed during tensile tests of magnesium and LiF single crystals and samples of polycrystalline molybdenum. Results on the LiF and molybdenum samples were similar: a preyield attenuation increase was observed which, however, became smaller as the magnitude of the drop in load at yielding increased. This indicated that the yield point observed in these materials is due to dislocation multiplication rather than dislocation unpinning and that the initial density of free dislocations must be low if the yield point is to be sharp. Tests on the magnesium were conducted at both 27 and 200°C. Magnesium has the property that the yield drop is larger at the higher test temperature and is accompanied by a decrease in attenuation. The latter is due principally to the temporary pinning of detained dislocations by highly mobile solute atoms. After strain aging, a stress as low as 0.3 bar suffices to unpin dislocations; microstrain measurements of sufficient sensitivity should reveal plastic flow at stress levels this low. (auth)

27549 EFFECT OF OXIDATION-PROTECTION COATINGS ON THE TENSILE BEHAVIOR OF REFRACTORY-METAL ALLOYS AT LOW TEMPERATURE. Imgram, A. G.; Bartlett, E. S.; Ogden, H. R. (Battelle Memorial Inst., Columbus, Ohio). Trans. Met. Soc. AIME, 236: 664-9(May 1966).

Unmodified disilicide coatings were applied to sheet-tensile specimens of Nb-D43 and Mo-TZM refractory-metal alloys. Coating thickness, degree of coating-substrate interdiffusion, and specimen geometry (notched and plain) were included in the variables studied. Tensile tests were made to determine the ductile-to-brittle transition temperature. The disilicide coating increased slightly the transition temperature of TZM, but had no effect on D43. Neither material condition (recrystallized or stress-relieved) nor specimen geometry (notched or unnotched) significantly altered the effects of coatings on the transition temperatures of the alloys. Cracks in the brittle coatings did not propagate into the substrate, and fracture modes appeared to be the same for both uncoated and coated specimens. (auth)

27550 MODIFICATION OF EUTECTIC ALLOYS FOR HIGH-TEMPERATURE SERVICE. Ashbrook, Richard L. (Lewis Research Center, Cleveland); Wallace, John F. Trans. Met. Soc. AIME, 236: 670-8(May 1966).

Several high-temperature eutectics of cobalt and nickel alloys were modified by small additions of selected elements. These alloys were compared to unmodified melts for microstructural variations. A few modified compositions were selected on the basis of structure and their tensile and stress-rupture behavior determined. The re-

sults of stress-rupture tests in air at 1800°F and room-temperature tensile tests of four high-temperature eutectics showed modification capable of producing substantial improvements in properties. The microstructures were altered and mechanical properties improved by: dispersing a subordinate phase more uniformly throughout the matrix; replacing large continuous-network or platelike constituents with small equiaxed discontinuous phases; and by forming new, finely divided phases. (auth)

27551 ANNEALING OF DEFORMATION TWINS IN COLUMBIUM. Ogle, J. C.; McHargue, C. J. (Oak Ridge National Lab., Tenn.). Trans. Met. Soc. AIME, 236: 686-94(May 1966). (ORNL-P-1819).

Lightly deformed Nb single crystals, which contained only parallel twins or parallel and intersecting twins, were annealed at 1000 and 1600°C. No recrystallization occurred in specimens having only parallel twins. Only noncoherent twin boundaries migrated at 1000°C but both coherent and noncoherent ones moved at 1600°C. Recrystallization occurred within a few minutes at twin intersections at 1000°C. The orientation of the recrystallized grains differed from that of both the matrix and deformation twins, but could be derived by ⟨110⟩ and/or ⟨112⟩ rotations. (auth)

27552 THERMAL-EXPANSION CHARACTERISTICS OF SEVERAL REFRACTORY METALS TO 2500 DEG C. Conway, J. B.; Losekamp, A. C. (General Electric Co., Cincinnati). Trans. Met. Soc. AIME, 236: 702-9(May 1966).

Thermal-expansion data for tungsten, rhenium, tantalum, molybdenum, niobium, W–25% Re, Ta–10% W, and Mo–50% Re are presented covering the range from room temperature to 2500°C. In these measurements, made in a resistively heated tungsten tube furnace operating in a helium atmosphere, data for rod and sheet specimens were found to be identical; in addition, arc-cast and sintered tungsten were found to yield essentially identical results. Optical measurements of thermal expansion made in any atmosphere other than vacuum are subject to a refraction error, which can be quite substantial. Specimens tested in helium appeared shorter than when tested in vacuum and hence a special correction factor had to be applied to the helium data in order to obtain accurate results. (auth)

27553 INFLUENCE OF HYDROGEN ON CRACK VELOCITY IN ZIRCONIUM IMPACT SPECIMENS. Coleman, C. E.; Hardie, D.; Wraith, A. E. (Univ. of Newcastle upon Tyne, Eng.). Trans. Met. Soc. AIME, 236: 750-2 (May 1966).

A photographic method of measuring crack velocities was applied to an examination of the effect of hydrogen on the impact properties of zirconium. Results indicated that the crack in hydrided zirconium travels at about 26 m per sec whereas that in the vacuum-annealed zirconium is dependent on the speed of the hammer. (auth)

27554 EFFECT OF CASTING TEMPERATURE ON THE CRYSTALLIZATION OF PRIMARY INTERMETALLIC COMPOUNDS. Malinovskii, R. R. Tsvetn. Metal., No. 3, 65-8(Mar. 1966). (In Russian).

Since some aluminum alloys contain a considerable quantity of refractory elements, which form intermetallic compounds such as $TiAl_3$, VAl_3, VAl_6, VAl_{11}, $CrAl_7$, $ZrAl_3$, $NbAl_3$, and $MoAl_3$, the effect of casting temperature on the primary crystallization of these compounds was studied. Small, 120-g alloy ingots were melted from AV000 aluminum and master alloys made with high-purity metals and potassium fluorozirconate. The ingots were cast at temperatures 30 to 50 and 400 to 500°C higher than the respective liquidus temperatures. It was found that the presence of solid particles in considerable quantity facilitates the crystallization of intermetallic compounds. At high temperatures, these particles are deactivated, i.e., dissolved in liquid metal. In the Al–1% Cr alloy the complete melting of the $CrAl_7$ compound occurred at 1005°C. Therefore, the number and the size of $CrAl_7$ crystals in alloy cast at 1050°C were much smaller than in the alloy cast at 800°C. The rest of the chromium remained in nonequilibrium solid solution, producing a higher hardness of the alloy. A similar effect was observed in Al–V alloys. In other systems the complete melting of intermetallic compounds occurred at a temperature higher than 1250°C, the maximum used in these experiments. The tested metals did not easily form a solid solution with aluminum. In these alloys an increase in casting temperature increased the size of the crystals of the intermetallic compound. Chromium and to some extent vanadium dissolved readily in an Al-base solid solution. The respective maximum solubilities of V and Cr in an Al-base solid solution were 0.37 and 0.85%. The maximum solubility of Zr, Nb, and Mo was 0.22 to 0.28% and that of Ta and W was 0.17 to 0.24%. For the Al–1% Cr–1% Zr alloy a casting temperature of 1050°C is recommended: it reduces the size of the $CrAl_7$ compound, strengthens the solid solution, and contributes to the uniformity of alloy structure. (ATD)

27555 μ PHASES. Raman, Aravamudhan (Univ. of Illinois, Urbana). Z. Metallk., 57: 301-5(Apr. 1966).

The crystal structure of the μ phases, the space filling concept applicable to the phases, and the "electron compound" nature of the phases are reviewed. Crystallographic data for four μ phases in the systems Nb–Co, Nb–Fe, Ta–Co, and Ta–Fe are given. The μ phases occur as electron compounds rather than size compounds and the sequence of structures with decreasing electron concentration (σ-μ-δ-CrB-CsCl) is dealt with. The Laues phases occur in most of the systems where σ, μ, δ, and CrB-type phases occur. (auth)

27556 INVESTIGATION OF THE PRECIPITATION BEHAVIOR OF NICKEL–MOLYBDENUM AND NICKEL–MOLYBDENUM–CHROMIUM ALLOYS. Schueller, Hans-Juergen; Schwaab, Paul; Albrecht, Karin (Forschungsinstitut der Mannesmann AG, Duisburg-Huckingen, Ger.). Z. Metallk., 57: 312-17(Apr. 1966). (In German).

In the temperature range between 500 and 1200°C the precipitation behavior of three alloys, i.e., a nickel–molybdenum alloy of the Hastelloy B type and two nickel–molybdenum–chromium alloys similar to Hastelloy C were investigated by light and electron microscopy. The phases were identified by electron diffraction. In the nickel–molybdenum alloy the δ-phase (NiMo) precipitated at high temperatures and the β-phase at temperatures below 800°C. The γ-phase (Ni_3Mo) was not observed. As cast, the first nickel–molybdenum–chromium alloy contained coarse precipitates of σ-phase, which a heat treatment transformed to P-phase but did not dissolve. During annealing in the temperature range used σ-phase was formed first. Later P-phase occurred and σ-phase started to transform to P-phase. The second Ni–Mo–Cr alloy differed from the first by the absence of silicon and iron as well as by a higher chromium content. The alloy was homogeneous above 1100°C. At lower temperatures σ-phase precipitated first, followed by P-phase. In the three alloys carbides of the $M_{23}C_6$ or M_6C type occurred in small amounts beside the intermetallic phases mentioned above. (auth)

27557 SHORT-RANGE ORDER IN THE NICKEL–TUNGSTEN SYSTEM. Baer, Hans Guenter (Vacuumschmelze AG, Hanau, Ger.). Z. Metallk., 57: 318-22(Apr. 1966). (In German).

Based on x-ray investigations of a single crystal, a statistic model of the short-range order, which occurs in the vicinity of Ni_4W after suitable heat treatment, was developed. According to this model the short-range order must not be considered as solely consisting of small regions of long-range order Ni_4W. (auth)

27558 ISOTOPE EFFECTS IN THE DIFFUSION OF HYDROGEN AND DEUTERIUM IN PUREST IRON. Heumann, Th.; Primas, D. (Univ., Muenster, Ger.). Z. Naturforsch., 21a: 260-5(Mar. 1966). (In German).

The diffusion of hydrogen and deuterium in purest iron was investigated using a gas-volumetric method as a function of the temperature between 300 and 1100°C and as a function of the charge pressure between 50 and 500 torr.

Equal activation enthalpies were obtained for hydrogen and deuterium in α- and γ-iron. The isotope effect of 1.2 determined as the mean from the diffusion coefficient of hydrogen and deuterium measured at equal temperatures deviated strongly from the value of 1.4 predicted by the Zener theory. (tr-auth)

27559 DETERMINATION OF THE ATOMIC VOLUME AND EXPANSION COEFFICIENTS IN SOME LIQUID LEAD–ZINC ALLOYS BY MEASUREMENT OF γ RADIATION ABSORPTION. Doege, G. (Technische Hochschule, Brunswick). Z. Naturforsch., 21a: 266-9(Mar. 1966). (In German).

A density apparatus for metallic melts, which depends on γ absorption measurements, is described. The atomic volume of liquid lead and zinc and the mean atomic volume of liquid alloys of these metals showed no deviation from the ideal pattern. The magnitude of thermal expansion corresponds only in the vicinity of the eutectic concentration to the additive rule and at other concentrations showed positive deviations from it. (tr-auth)

27560 TUNGSTEN TRIOXIDE AND ITS REACTIONS WITH OXIDES OF DIVALENT METALS. I. PHASE TRANSFORMATION AND TWINNING STRUCTURE OF TUNGSTEN TRIOXIDE. Leute, Volkmar (Univ., Munich). Z. Phys. Chem. (Frankfurt), 48: 307-18(Mar. 1966). (In German).

Indications of a cubic phase of WO_3 existing above 900°C are described. The twinning structure of WO_3 single crystals in normal and polarized light was investigated and an explanation is given of the wedge-shaped twin in WO_3. Microscopic investigation of the polymorphous transformation of WO_3 at 760°C led to the assumption that it is probably a diffusionless transition without a determinable temperature hysteresis. The pressure sensitivity of the twinning structure of WO_3 is considered. (tr-auth)

27561 PRODUCTION OF OXIDE FILMS IN STRUCTURE STUDIES OF Zr–Nb ALLOYS. Sudareva, S. V.; Buinov, N. N.; Vozilkin, V. A. (Inst. of Metal Physics, Academy of Sciences, USSR). Zavodsk. Lab., 32: 212-13(1966). (In Russian).

The structure of the Zr-rich portion of the superconducting Zr–Nb system was examined by oxidizing the specimens in boiling chloride solutions; alloys containing <4% Nb were treated with a 10-% $MgCl_2$ solution and with >4% Nb with a 10-% NH_4Cl solution for 6 hr. Before forming the corrosion-resistant film, the specimens were etched and polished in order to remove extraneous materials. The oxide replicas were removed from the alloy surface electrolytically in a methanol solution of bromine, using a silver cathode at a voltage of <35v. The replicas were washed with HCl and water. Electronograms obtained with these replicas revealed an uneven blackening of the diffraction rings, indicating special orientation of the crystals. The excellent resolution obtained with these oxide films allowed particles of about 30 A to be observed. The method may also be applied to the Nb–Ti system. (TTT)

27562 GRAPHITE HEAT CAPACITY AT 1750 TO 2850 DEG K. Kraftmakher, Ya. A.; Shestopal, V. O. Zh. Prikl. Mekh. Tekh. Fiz., No. 4, 170-1(July-Aug. 1965). (In Russian).

Results of the measurement of the specific heat of graphite in the range 1750 to 2850°K by the modulation method using color pyrometry are reported. The theoretically determined temperature oscillations of the sample were found to vary from 1 to 15 degrees, and the measured specific heat of graphite is shown graphically for 5 samples. (J.F.P.)

27563 THEORY OF MAGNETISM IN THE RARE EARTH METALS. Elliott, R. J. pp 385-424 of Magnetism. Volume IIA. New York, Academic Press, 1965.

The properties of metals are reviewed from the viewpoint of the action of the crystal field on ions with $4f^n$ configurations coupled by exchange interactions. The crystal structure of the rare earths and the band structure of their three conduction electrons are outlined. Neutron diffraction and bulk magnetic measurement results are given. The theory of molecular fields, spatial dependence of exchange, low-temperature ordering, spin waves, the crystal field in heavy and light rare earths and in Gd, the theory of exchange interactions including the Rudermann-Kittel interaction, super-zone boundaries, and the effects of boundaries and scattering on Rudermann-Kittel interactions are discussed. (Rev. Metal Lit.)

27564 ELECTRICAL CONDUCTION AND DIELECTRIC PROPERTIES OF CERAMIC AND SINGLE CRYSTAL CERIUM OXIDE. Kevane, C. J.; Holverson, E. L.; Armstrong, James B. (Arizona State Univ., Tempe). 12p. (CONF-650804–25). ORAU. Gmelin, AED-CONF-65-208-26.

From 5th Rare Earth Research Conference, Ames, Iowa.

Studies of electrical conduction in ceramic and single-crystal cerium oxide were carried out over a temperature range from 250 to 1500°C. The studies involved two- and four-contact d-c measurements of conductivity and a-c bridge measurements of dielectric constant and dielectric loss in the audio frequency range. Composition changes were made by varying oxygen partial pressure between 1.0 and 10^{-4} atm. Impurity concentrations were determined spectrographically. When calcium impurities were present, the results showed appreciable conduction by oxygen ions below 600°C as evidenced by the evolution of oxygen gas, discolorations of the samples, non-linear potential distributions, and current transients. The dielectric constant of ceramic cerium oxide was found to be strongly frequency dependent but in agreement with the optical dielectric constant at higher frequencies. The dielectric loss factor showed pronounced peaks in both ceramic and single crystal samples and was interpreted in terms of impurity-vacancy complexes. The four-contact d-c conductivity varied from $10^{-2}(\text{ohm-cm})^{-1}$ at 1500°C down to $10^{-11}(\text{ohm-cm})^{-1}$ at 250°C and depended also on oxygen gas pressure and on impurity content. The conductivity dependence on oxygen partial pressure indicated n-type conduction at temperatures above 1200°C. Below 1200°C the logarithmic plot of conductivity against oxygen partial pressure showed well-defined minima and indicated regions of p-type conduction which were confirmed by the sign of Seebeck coefficient. These general features were seen for single-crystal as well as ceramic samples. (auth)

Radiation Effects

See also CHEMISTRY — Radiation Chemistry

Refer also to abstract 28793.

27565 (AAEC/TM–306) INACTIVE DILUENTS FOR FISSILE-FERTILE OXIDES IN BeO MATRIX DISPERSION FUELS. Reeve, K. D. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Dec. 1965. 22p. Dep. mn.

The dilution of plutonium dioxide and $(Pu,Th)O_2$ particles in BeO matrix dispersion fuels to decrease the fission density at high burnups is considered. Possible diluents are first discussed in terms of their phase relations with fissile and fertile oxides. Published information on the irradiation behavior of diluted UO_2 fuels is then reviewed. It was concluded that dilution of fissile-fertile particles in BeO matrices would be worthwhile but that a choice cannot at present be made between ZrO_2 and CeO_2 for this purpose. (auth)

27566 (AERE-R–5194) THE EFFECT OF FAST NEUTRON IRRADIATION ON THE MAGNETIC PROPERTIES OF TWO SILICON–IRON ALLOYS. Stephen, J. (Atomic Energy Research Establishment, Harwell (England)). Jan. 1966. 21p. Dep. mn. BIS $0.80, HMSO 4s.

A fast neutron irradiation experiment conducted on two silicon–iron alloys is described. Changes in the magnetic properties are given for an irradiation dose of 1.6×10^{20} fast neutrons/cm^2 at temperatures below 135°C. Both alloys exhibit a damage threshold at a dose of about 1.25 to 5×10^{17} fast neutrons/cm^2, above which the saturation and remanent fluxes decrease and the coercivity increases. These changes then remain constant for a further large

increase in the fast neutron dose. The results are discussed in terms of the interaction between the inclusions and internal stresses due to the radiation and the domain walls. (auth)

27567 (BMI–1766) FISSION-FRAGMENT EFFECTS IN STRUCTURAL MATERIALS. De Mastry, John A.; Ritzman, Robert L.; Griesenauer, Neal M.; Jablonowski, Edward J.; Shober, Frederic R.; McCall, James L.; Price, Robert B.; Townley, Charles W. (Battelle Memorial Inst., Columbus, Ohio). Mar. 22, 1966. Contract W-7405-eng-92. 53p. (EURAEC–1631). Dep. mn. CFSTI $3.00 cy, $0.50 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Fission-fragment effects were studied in Type-304 stainless steel and Zircaloy-2 for short-time exposures at 150°C. A concentration of about 2.1×10^{14} fission fragments per cm^2 had little, if any, effect on the mechanical properties of Type-304 stainless steel or Zircaloy-2 as determined in bending. Increases of strength on the order of 7 to 10% were noted in tube-burst specimens of the structural materials. Electron fractographic studies did not reveal any changes in the fracture modes of either type of material as a result of exposure to neutron irradiation or fission fragments. Strain studies indicated that there is significant compression stress on the cladding at temperatures below 150°C. Much of this damage is expected to anneal out at higher reactor operating temperatures. (auth)

27568 (BMI–1772) ETR IRRADIATIONS OF PYROLYTIC-CARBON-COATED FUEL PARTICLES. Miller, Neil E.; Martin, Robert L.; Rosenberg, Harvey S.; Price, Robert B.; Townley, Charles W. (Battelle Memorial Inst., Columbus, Ohio). May 11, 1966. Contract W-7405-eng-92. 35p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

Triplicate specimens of each of 25 lots of PyC-coated fuel particles were irradiated in the ETR at temperatures of nominally 550, 1100, and 1300 C to burnups on the order of 2×10^{21} fissions per cm^3. The samples included coatings of monolithic laminar pyrolytic carbon, duplex pyrolytic carbon (laminar over porous), and composite pyrolytic carbon (PyC over BeO or SiC) applied to uranium- or (thorium-uranium)-base fuel particles. Postirradiation fission-gas-release measurements and metallographic examinations were used to study the effects of coating composition and thickness, fuel composition and density, and irradiation temperature. No definite effects of fuel composition and irradiation temperature were observed. Duplex and composite coatings showed the best performance with some additional improvement noted when used on fuel cores of lower density. Of the monolithic coatings, only the thick coating showed no failure. Results of four irradiations at the BRR showed no failure of monolithic PyC coatings on large, porous UO_2 particles irradiated to high burnup. (auth)

27569 (BNWL–207, pp 3.7-13) RADIATION EFFECTS ON METALS. Brimhall, J. L.; Kissinger, H. E.; Mastel, B.; Smidt, F. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Dark-field electron microscopy was applied to neutron-irradiated nickel. Both vacancy and interstitial clusters were identified; the majority of the clusters are vacancy in nature. The absence of small-angle scattering from irradiated nickel led to the conclusion that the cluster defects must be two-dimensional in nature. Electron microscopy of neutron-irradiated Cu + 8% Al, a low stacking fault energy alloy, showed the expected defect clusters. Deformation of the irradiated alloy results in a structure similar to the unirradiated condition and in this respect differs from the channeling of dislocations in irradiated nickel and molybdenum. Experimental techniques particularly in eliminating Bragg scattering effects in small-angle scattering were refined. The only measurable small-angle scattering obtained on irradiated material thus far was from molybdenum irradiated to 1×10^{20} nvt (E > 1 Mev). (auth)

27570 (BNWL–207, pp 3.17-35) SWELLING OF IRRADIATED FISSIONABLE MATERIALS. Leggett, R. D.; Hann, C. R.; Mastel, B.; Merckx, K. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

An irradiation program designed to study the influence of irradiation variables such as specimen temperature, burnup, burnup rate, and external pressure and metallurgical variables such as composition, structure, and geometry on swelling of fissionable materials was continued. Postirradiation examination of specimens recovered from three capsules each with pressure controlled at 1000 psi and with temperature controlled at 450, 575, and 625°C respectively was completed. The results show that pressure can markedly reduce swelling in certain instances. Evidence is presented that C in U, rather than Fe–Si, is a constituent responsible for reducing swelling. Fission rate increases due to increases in the ^{235}U content of specimens by a factor as high as 4 do not appear to alter the shape of the swelling-temperature curve of U for burnups to ~0.4 at %. Metallography on specimens irradiated at 525°C and then at 200°C shows that the planes on which tears develop during the 525°C irradiation are also the planes on which deformation occurs during irradiation at 200°C. A computer program for numerically evaluating metallographic data from replicas was reprogrammed and adapted for UNIVAC-1107 use. (auth)

27571 (BNWL–207, pp 4.1-3) ALLOY SELECTION. Claudson, T. T. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Several Ni base and refractory metal alloys were irradiated in the ETR at 50°C, and their tensile properties were tested at 1090°C. In tests on W-25 Re rod material, full recovery of properties was not found as indicated by the increase in both yield strength and ultimate tensile strength as compared to the control specimen. The ductility of the specimens was decreased as indicated by the lower percent reduction in areas and total elongation. Specimens irradiated to 3.4×10^{20} nvt showed no effect of strain hardening, but specimens irradiated to 5.6×10^{20} nvt exhibited significant strain hardening. Results of tensile tests on W-25 Re, Cb-752, Cb-1 Zr, Mo, and TZM are tabulated. The properties of Cb-752, Cb-1 Zr, and Mo tested after irradiation showed essentially complete recovery when compared to control specimens. The irradiated specimen of TZM showed slight increase in yield strength and a decrease in both total elongation and reduction in area. (A.G.W.)

27572 (BNWL–207, pp 4.4-7) IRRADIATION FACILITIES OPERATION. Irvin, J. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

With the conclusion of ETR cycles 73 through 76, over 200 irradiated tensile, stress rupture, and fracture specimens were discharged from the ETR G-7 hot water loop and other core positions. Materials irradiated at 290 and 50°C include stainless steels, Zircaloy-2, and nickel-base alloys. Over 85 control specimens were discharged from the out-of-reactor loop during this same period. Many of these specimens have been tested and the data are currently being processed. The REM master file currently contains approximately 4000 tensile test records on 40 or more alloys examined on the Irradiation Effects to Reactor Materials Program. Summary reports of the processed data for specific alloys are being generated. The REM program is being converted to FORTRAN IV for processing on the UNIVAC 1107 computer. (auth)

27573 (BNWL–207, pp 4.8-31) IRRADIATION DAMAGE TO STAINLESS STEELS. Irvin, J. E.; Brimhall, J. L.; Mastel, B. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Tensile tests were conducted on AISI 304, 316-L, and 348 stainless steels irradiated in the ETR. Tests were conducted at test temperatures between room temperature and 800°C. The results to date indicate areas of minimum ductility between 200 and 400°C and above 600°C. The regions of low ductility vary with fabrication history, chemical composition, metallurgical structure, test temperature, and irradiation temperature. The mode of failure in the intermediate temperature region is primarily transgranular and probably involves an aging process not normally associated

with austenitic stainless steels in this temperature range. Further studies using transmission electron microscopy are in progress. The high-temperature failure is predominantly intergranular in nature and can also be influenced by anything that changes the relative strength of the matrix with respect to the grain boundary. The influence of various thermal and mechanical treatments during the fabrication of reactor components on the metallurgical stability of the alloys during reactor service is being examined. (A.G.W.)

27574 (BNWL–207, pp 4.32-4) IRRADIATION DAMAGE TO ZIRCALOY-2. Irvin, J. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Conclusions drawn from a study of effects of irradiation and environment on mechanical properties of Zircaloy-2 are listed briefly. A topical report being published on the effects of irradiation and environment on transition joints between Zircaloy-2 and Inconel 600 is summarized. (A.G.W.)

27575 (BNWL–207, pp 4.35-43) IRRADIATION DAMAGE TO NICKEL-BASE ALLOYS. Levy, I. S.; Wheeler, K. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Efforts to modify the microstructure of nickel-base alloys by preirradiation treatment to reduce the embrittlement induced by irradiation at high temperatures were continued. Metallography of tensile specimens of Hastelloy X-280 tested at 1350°F showed evidence that strain, irradiation, and combinations of strain and irradiation induce an increase in precipitate volume in both matrix and grain boundary areas. Correlations are being made between observed microstructural changes in Hastelloy X-280 and its mechanical properties. Preliminary creep-rupture data from four of a series of ten irradiated Hastelloy X-280 samples with varying preconditioning treatments indicate differences in creep-rupture life as a result of different preconditioning treatments. Irradiated tensile results obtained on preirradiation-treated Inconel X-750 indicate all specimens were extremely brittle. Both strength and ductility decreased with the degree of over aging. (A.G.W.)

27576 (BNWL–207, pp 4.44-55) FRACTURE STUDIES. Rowe, R. G. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Zircaloy-2 DCB specimens irradiated at 280°C in the G-7 hot water loop of the ETR were tested to determine their fracture toughness as a function of temperature and the level of neutron irradiation. It was found that the fracture toughness (K_{1C}) was substantially reduced when exposed to a level of 5×10^{20} nvt. Brittle behavior was seen to occur at much higher temperatures. It was also determined that the critical flaw size in a tensile plate increases as the level of irradiation and temperature increases. Tests of stable crack propagation in D2 tool steel at loads less than that required for dynamic or unstable cracking and at temperatures of 0 to 200°C in air showed that the crack progressed in discrete jumps and that the time between jumps and the magnitude of each jump are both temperature and stress dependent. Further tests were performed in vacuum and in argon at temperatures up to 450°C. The rate of crack propagation in vacuum was greater than an order of magnitude less than that in air for the same value of the stress field coefficient. Preliminary investigations of the fracture toughness of graphite DCB specimens demonstrated the effectiveness of the DCB specimen in testing brittle engineering materials other than metals. (A.G.W.)

27577 (BNWL–207, pp 6.1-6) PRTR PRESSURE TUBES. Fraser, M. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Ring-type specimens were cut from an irradiated PRTR tube and tensile-tested after being held for one, two, three, or four thousand hours in a neutral atmosphere and at a temperature of 550°F. Analysis of the data obtained indicated strength reduction during the first 1000 hr and then an increase in strength during the remaining 3000 hr. The strength increase indicates an aging process within the Zircaloy-2 alloy. Observation of the microstructure near the rupture in a Zircaloy-2 pressure tube that failed during performance of an experiment with the PRTR fuel element rupture facility showed that the tube had been locally heated to a temperature within the range 1480 to 1770°F or possibly higher. Simulation of the event indicated that the strength of the tube at these temperatures would have been overcome by PRTR system pressure. (auth)

27578 (BNWL–SA–56) THE TENSILE FRACTURE STRAIN OF GRAPHITE DETERMINED DURING NEUTRON IRRADIATION. Jackson, J. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 14, 1965, Contract AT(45-1)-1830. 10p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Tensile fracture strain of EGCR-type AGOT graphite in an irradiation environment at 625°C was measured. Parallel cut samples were irradiated at a nominal strain rate of 0.13% per 10^{20} n/cm^2. Strains without fracture from 0.37 to 0.42% were obtained, compared to strains at fracture of 0.1 to 0.2% for unirradiated material. (P.C.H.)

27579 (EURAEC–1580) STUDY OF FISSION GAS RELEASE FROM SPECIMENS OF UO_2 IRRADIATED AT VARIOUS DOSES. Report No. M/396. Quarterly Report No. 1, November–December 1965. Baffigo, V.; Gerevini, T. (comps.) (Societa Ricerche Impianti Nucleari, Saluggia (Italy). Centro Ricerche Nucleari). Jan. 1966. Contract 043-65 TEEI (RD). 17p. (EUR–2809). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Specimen characteristics, hot cell modifications, measurement of temperature between pellets and monocrystal, and encapsulation of specimens is described for studies that are to be made on dependence of irradiation dose of the diffusion coefficient of xenon diffusion in UO_2, as measured in post-irradiation annealing experiments. (P.C.H.)

27580 (GA–6996) A PROGRAM OF BASIC RESEARCH ON MECHANICAL PROPERTIES OF REACTOR MATERIALS. Quarterly Progress Report, November 1, 1965–January 31, 1966. Chambers, R. H.; Trozera, T. A. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Mar. 28, 1966. Contract AT(04-3)-167. 22p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Resistivity measurements are used to characterize the changes in properties of reactor materials due to neutron irradiation. Calculations are presented for a correction to the resistivity ratio for orbital scattering of conduction electrons at the surface of the crystal. A new nondestructive and highly reproducible method of measuring the preyield plastic properties of relatively brittle metals is described. (W.L.G.)

27581 (GEAP–5100F) HIGH PERFORMANCE UO_2 PROGRAM. IRRADIATION OF 0.5-INCH DIAMETER, SWAGED POWDER UO_2 FUEL RODS AT 600,000 AND 800,000 BTU/H-FT^2 PEAK HEAT FLUX. Lyons, M. F.; Nelson, R. C.; Pashos, T. J.; Wilson, C. R.; Weidenbaum, B. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Jan. 1966. Contract AT(04-3)-189, 85p. (EURAEC–1602). Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

The fabrication data, irradiation history, and the complete correlated postirradiation examination results are described for a four-rod fuel assembly designated EPW-6/8. The fuel rods in this assembly were unsegmented, reactor-length rods, clad in free-standing Zircaloy-2 and fabricated by vibratory compaction and swaging to an average bulk density of 90 to 91%. This fuel assembly was the first of a series irradiated to determine the feasibility and limitations in operating compacted powder UO_2 fuel rods with central melting. The first powder fuel irradiation was preceded by the entire series of exploratory pellet fuel assembly irradiations. These earlier irradiations had shown clad swelling from the UO_2 phase change volume expansion was the basic problem in operating with central melting. Further tests had demonstrated that the clad swelling could be prevented by the provision of internal free volume in the

form of hollow pellets to accommodate the UO_2 volume expansion. On this basis the somewhat lower density powder rods (90 to 91% compared to 92 to 93% effective bulk density for the solid pellet rod) were tentatively expected to be less subject to clad swelling. The EPW-6/8 assembly irradiation provided the first indication that powder fuel rod swelling was, in fact, greater than that with pellets. Later work showed that powder fuel rod swelling could also be prevented by reduced initial fuel density. (auth)

27582 (GEMP-400A, pp 63-98) EFFECT OF RADIATION ON REFRACTORY METALS. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation).

Neutron irradiation of both commercial and GE-NMPO-produced W–25Re at reactor ambient temperature to 6.8×10^{19} nvt ($E_n \geq 1$ Mev) increases the rupture life at 800 to 900°C with a more pronounced stress dependency apparent at the lower temperature. Total elongation is not significantly affected by irradiation. Annealing at 1700°C results in only partial recovery. The creep-rupture properties of TZM alloy at 1300°C are unaffected by the above irradiation. For the case of creep-rupture properties of irradiated W it is shown that the 10-hr flow stress varies linearly with fast neutron fluence level when specimens are tested at 1100°C. Tensile strength at 240°C of neutron-irradiated W is increased on annealing in the temperature range of 430 to 750°C; rapid recovery occurs above this temperature until essentially complete recovery is reached at 1050°C. These data and other tensile data on Mo and Nb show that complete recovery of the tensile properties of irradiated bcc metals appears to occur at a homologous temperature of 0.35 T_m or lower. The large decrease in resistivity of irradiated W at 0.15 T_m appears to be related to the corresponding increase in hardness at 0.16 T_m as both changes show the same fast neutron fluence dependency. (W.L.G.)

27583 (GEMP-400A, pp 99-107) FISSION PRODUCT TRANSPORT PROCESSES IN REFRACTORY-METAL FUEL SYSTEMS. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation).

The diffusion of ^{85}Kr in arc-cast Ta at 1400 to 1800°C is of short range, being from 500 to 1000 Å along high diffusivity paths; this is consistent with in-pile test data at 1800 to 2000°C in which there was no evidence for diffusion of fission gases through 0.4- to 0.5-mm-thick Ta. The permeation coefficient for Kr through arc-cast Ta at 2400°C and a pressure differential of 625 torr is less than 4×10^{-15} cc (STP)-mm/cm^2-sec-cm of Hg. (W.L.G.)

27584 (GEMP-400A, pp 169-84) EFFECT OF RADIATION ON HEAT RESISTANT METALS AND ALLOYS. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation).

The rupture life of irradiated Hastelloy N at 650°C is about 0.1 to 0.05 that of unirradiated Hastelloy N and the reduction is apparently independent of irradiation temperature (reactor ambient or 650°C). At 650 and 815°C there is a significant loss in rupture ductility following irradiation. As-welded and welded-irradiated Hastelloy N have rupture lives at 650°C about one-tenth that of the unirradiated, unwelded material. Irradiated iron-base precipitation hardening alloys (A-286) containing the least amount of B have the greatest reduction in creep-rupture properties. Computer calculations indicate the increase in the lower yield point of α-iron and ferritic steels, induced by irradiation, is in better correlation with the density of displacement spikes (PKA's > 3 kev) than with the total number of displaced atoms. (W.L.G.)

27585 (GEMP-400A, pp 221-62) RADIATION EFFECTS IN BeO. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation).

In studies of irradiated BeO, there were further developments in the kinetics of expansion, He bubble volume, and compositions with improved resistance to microcracking. Identification of the defect clusters formed in BeO irradiated at elevated temperatures as interstitial led to some revision of the kinetics of the expansion. It appears that the experimentally derived equation for expansion exclusive of microcracking and helium bubbles is essentially correct and that a flux dependent saturation of the expansion will occur. Indications are, however, that expansion due to He bubbles will continue beyond that due to lattice defects and will probably determine the maximum exposure for the material. Two BeO compositions were found with improved resistance to microcracking: UOX-grade BeO plus 0.4 wt. % Al_2O_3 and 0.1% SiO_2, and UOX-grade BeO plus 1.0% bentonite in a small (<5 micron) grain size. (auth)

27586 (GEMP-400A, pp 269-77) INTERNAL CONVERSION CERAMIC FUEL ELEMENT RESEARCH. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation).

$UO_2-ThO_2-Y_2O_3$ fuel in an unclad BeO matrix has excellent thermal stability, indicating a capability of 15,000 hours life at 1200°C in air with 1% or less UO_2 loss or at 1400°C in air with 2% or less UO_2 loss. Irradiation of BeO containing 25 vol % $UO_2-ThO_2-Y_2O_3$ in the ETR to a fuel phase burnup of 14×10^{20} fissions/cm^3 caused no significant deterioration in physical or mechanical properties and no change in appearance or microstructure. Dynamic irradiation tests at 1250 to 1550°C showed recoil to be the dominant fission gas release process with no significant diffusion contribution. Slurry-applied BeO coatings, sintered at 1800°C, reduced fission gas release by factors of 20 to 100 down to R/B values of 10^{-6}. (W.L.G.)

27587 (GEMP-400A, pp 279-81) FISSION GAS DIFFUSION IN UNFUELED CERAMIC MATERIALS. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation).

Beryllia and sapphire targets were bombarded with 35 kev Kr ions and the amount of Kr diffusant remaining in a target specimen was measured as a function of time at constant temperatures of 1100 and 1200°C. A temperature dependency of the Kr release was apparent in the beryllia samples, but not in the sapphire. The observed release in the sapphire samples suggest that the crystal lattice orientation during injection influences the magnitude of the initial release. (W.L.G.)

27588 (LA-DC-6822) IRRADIATION DAMAGE TO CERAMICS AND METALLIC CERAMIC BONDS. Patrick, Alton J.; Stoddard, Stephen D. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). May 1965. Contract W-7405-eng-36. 37p. (CONF-650513-5). Dep. mn. CFSTI $2.00 cy, $0.50 mn.

From American Ceramic Society, Annual Meeting, Philadelphia.

Irradiation damage to ceramics and metallic-ceramic bonds is described for a temperature range of 700 to 970°K. Data are presented for an accumulated thermal neutron flux from 1.36×10^{21} to 2.77×10^{21} nvt and for an accumulated fast neutron flux (>1 Mev) from 1.5×10^{20} to 3.17×10^{20} nvt. In this temperature range, the BeO, MgO, magnesia spinel and Y_2O_3 samples were found to be unsatisfactory. 97.5% Al_2O_3, $Al_2O_3-2\%Y_2O_3$, and $Al_2O_3-0.5\%Y_2O_4$ were found to be the most resistive to irradiation damage. The electrical resistivity of the ceramics tested was lower after irradiation. (auth)

27589 (NASA-CR-54881) EFFECT OF NUCLEAR RADIATION ON MATERIALS AT CRYOGENIC TEMPERATURES. Final Report. (Lockheed Nuclear Products, Marietta, Ga.). Jan. 1965. Contracts NAS-3-7987; NASw-114. 308p. (LAC-ER-8434).

The tensile testing was performed under three conditions; at room temperature without irradiation, at 30°R without irradiation, at 30°R in a high flux zone of a nuclear reactor after 1×10^{17} nvt (E > 0.5 Mev) at the same temperature. The irradiation times varied from 11 to 17 hr. Special remote handling and test equipment was designed and fabricated and installed to allow remote manipulation and testing under 20 ft of shielding water. Specimen temperature control was provided by a 1150 w refrigeration system using gaseous He as the cryogenic fluid. The materials tested included thirteen Al alloys; six different Ti alloys or alloy conditions; four Ni alloys; and ten different Fe alloys or alloy conditions. The properties that were measured were the yield strength, the ultimate strength, the elongation, the reduction of area and, in some materials, the notched

ultimate strength. Aluminum alloy 1099 (-H14) showed a previously unreported reduction in tensile yield strength at 30°R unirradiated which was fully recovered with irradiation. The heat treatable high-Cu Al alloys and the Al–Mg–Si alloy 6061 show a consistent reduction of ultimate strength due to irradiation at 30°R. The high-Mg low-Zn Al alloys gave no indication of serious deterioration of mechanical properties due to irradiation. The Ti alloys tested exhibited similar cryogenic and irradiation effects. They showed generally increased strength due to the cryogenic environment and, with the exception of the 5% Al–2½% Sn, with extra low interstitial content, also showed generally increased strengths due to irradiation at 30°R. The nickel alloys, Rene 41 and Inconel X show significant decreases in notch strength due to irradiation, while K-Monel shows an increase in yield strength and Inconel shows an increase in notch strength due to irradiation at 30°R. The cryogenic and nuclear cryogenic effects in the austenitic stainless steels appear to be a function of the austenitic stability. ASTM A 353 appears to be the only nonaustenitic steel tested to show improved characteristics due to both cryogenic and nuclear cryogenic environments. (auth)

27590 (ORNL–3930) AN EVALUATION OF UO_2 IRRADIATED AT 1600 TO 2400 DEG C. Michelson, C.; Scott, J. L.; Long, E. L. Jr. (Oak Ridge National Lab., Tenn.). May 1966. Contract W-7405-eng-26. 66p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Four heavy-wall Inconel capsules were prepared for irradiation in an air-cooled loop in the Low Intensity Test Reactor at Oak Ridge. Each capsule was closed at midlength to form two gas-tight compartments, which were filled with argon. Each compartment contained three 20%-enriched UO_2 fuel bushings 0.2 cm ID, 0.4 cm OD, and 0.6 cm long. The basic plan was to irradiate these capsules at fuel temperatures exceeding 1900°C and burnups ranging from 0.01 to 1.0 at. %. The objective was to determine fission-gas release and evaluate microstructural changes as a function of burnup. The thermal neutron flux was about 1.7×10^{13} neutrons cm^{-2} sec^{-1}. Photomicrographs of the low burnup capsule (0.01 at. %) showed well-established, long columnar grains and numerous lenticular voids in the enriched and depleted zones where the calculated temperature exceeds 1700 to 1750°C. Photomicrographs of longer burnup capsules (up to 1845 hr in reactor) showed the same spatial distribution of well-established, long columnar grains, but the lenticular voids were no longer present. A plot of maximum grain length vs temperature revealed that, in general, all capsules had the same grain-length distribution, regardless of irradiation time. Some tendency toward grain-length reduction with increasing burnup was noted but considered inconclusive. (P.C.H.)

27591 (ORNL-TM–1427) DESIGN OF AN IRRADIATION EXPERIMENT TO TEST COATED-PARTICLE FUELS TO HIGH BURNUP. Longest, A. W.; Conlin, J. A. (Oak Ridge National Lab., Tenn.). May 1966. Contract W-7405-eng-26. 81p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

A capsule irradiation experiment was designed to evaluate the performance of pyrolytic-carbon-coated UO_2 and UC_2 particles to burnup in the range of 50–60 at. % heavy metal. The irradiation is to be conducted in the ORR F-9 Facility. Burnup rate is to be limited to a maximum of 10 at. % heavy metal per month and fuel temperature is to be maintained between 1100 and 1400°C throughout the one-year irradiation, with emphasis on the higher temperature. The fuel specimens are to be continuously swept with an inert gas purge, which is periodically sampled for fission-gas release measurements. The capsule has two batches of fuel particles, each in an annular monolayer supported in a graphite structure. Each batch contains ~0.1 g of 93% enriched uranium. (auth)

27592 (ORNL-TM–1474) DESIGN FOR HIGH-TEMPERATURE TENSILE SPECIMEN IRRADIATION EXPERIMENT, ORNL 41-31. Zulliger, A. F.; Lauterbach, H. H. (Oak Ridge National Lab., Tenn.). May 1966. Contract W-7405-eng-26. 69p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

In order to determine the effects of radiation on the mechanical properties of INOR-8, the High-Temperature Tensile Specimen Irradiation Experiment was designed to irradiate 126 tensile test specimens of INOR-8 at a temperature of 600°C in the Engineering Test Reactor. The procedures, calculations, and data evolved in the design for this uninstrumented experiment are reported. (auth)

27593 (UNC–5134(Vol.2)) CARBIDE FUEL DEVELOPMENT. Final Report, May 15, 1959–October 15, 1965. Strasser, A.; Cihi, J. (United Nuclear Corp., Elmsford, N. Y.). Oct. 15, 1965. Contracts AT(30-1)-2899; AT(30-1)-2303. 196p. Dep. mn; CFSTI $5.00 cy, $1.25 mn.

Irradiation tests of 12 clad $(U_{0.8}Pu_{0.2})C$ specimens in the range of 20,000 to 113,000 Mwd/T at 490 to 570 w/cm (avg) demonstrated the structural and dimensional stability of the fuel. The microstructure of the fuel was essentially unchanged by irradiation. The fuel OD increased 0.5 to 0.6% per at. % burnup. The fission gas release increased from less than 1% at 7×10^{20} fiss/cm^3 and 1% at 13×10^{20} fiss/cm^3 to 30% at 38×10^{20} fiss/cm^3. This was accompanied by a significant increase in fuel porosity at the center. No significant differences were noted between the 91% dense fuel without sintering aid, and the 95% dense fuel made with Ni sintering aid. The six Nb-clad specimens were sound and in excellent condition. The clad OD was unchanged up to 35,000 Mwd/T. At 114,000 Mwd/T, there was an average 2.5% OD increase. Of the six stainless steel-clad specimens, one was in excellent condition, one failed because of an experiment malfunction, and four were ruptured as a result of the drastic decrease in steel ductility to a level below that required to accommodate strains from fuel expansion and thermal stresses. (W.L.G.)

27594 (ORNL-tr–1236) LENGTH MEASUREMENTS ON NEUTRON-IRRADIATED PURE IRON. Bonjour, Emmanuel; Vigier, Pierre; Moser, Pierre (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Translated by Gerard deSaussure (Oak Ridge National Lab., Tenn.), from a preprint. 5p. Dep. mn. JCL $1.10 fs, $0.80 mf.

The volume variations of an iron sample neutron irradiated at 77°K are measured during a linear temperature rise. Different recovery stages were observed in good agreement with those found by resistivity and magnetic after effect measurements. Arguments are given for attributing the largest stage to the recovery of iron interstitials in their parent vacancy. A rough estimate of the volume occupied by an interstitial gave a value appreciably larger than the atomic volume. (auth)

27595 RECOVERY STAGE III IN DECARBONIZED TUNGSTEN AFTER NEUTRON IRRADIATION AT 4.5 DEG K. Kuhlmann, H.-H.; Schultz, H. (OSRAM, Augsburg, Ger.). Acta Met., 14: 798-800(June 1966). (In German).

The stage III recovery of the electric resistance of tungsten was studied on decarbonized samples. The degassing and decarbonizing procedure is described. The samples were then irradiated at 4.5°K with a dose of 7×10^{17} neutrons/cm^2. The isochronic recovery was measured from 4.5 to 420°K. Measurements from 440 to 850°K were carried out after decay of the radioactivity. A recovery stage III appears at 400 to 500°C. The residual resistance behavior is changed in this stage from 0.78 to 0.28%. This resistance change corresponds to a concentration change of point defects of approximately 10^{-4}. The effect is so large that it cannot be attributed to the low concentration of interstitial atoms but the localized distortion must also be considered. (J.S.R.)

27596 EFFECTS OF NEUTRON IRRADIATION ON PROPERTIES OF HIGHLY ALLOYED FERRITIC STEELS. Ibragimov, Sh. Sh.; Voronin, I. M.; Ladygin, A. Ya. At. Energ. (USSR), 20: 137-40(Feb. 1966). (In Russian).

Some data on the effects of neutron irradiation on the mechanical properties of iron and ferritic steel are presented. The materials were irradiated to different integral doses at temperature from 40 to 600°C. The

effect of some alloying additions on the sensitivity of steel to radiation is explained. (tr-auth)

27597 ION-BOMBARDMENT-INDUCED RADIATION DAMAGE IN SOME CERAMICS AND IONIC CRYSTALS. Matzke, Hj.; Whitton, J. L. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys., 44: 995-1010 (May 1966). (AECL-2413).

Single-crystal specimens or polycrystalline sinters of cubic NaCl, KCl, KBr, KI, MgO, CaO, NiO, UC, CaF_2, BaF_2, UO_2, and ThO_2 as well as anisotropic TiO_2, Al_2O_3, and U_3O_8 were bombarded with 40-kev xenon or krypton ions to give integrated ion doses of up to 2×10^{16} ions/cm^2. The specimens were examined by reflection electron diffraction for radiation damage in the form of a phase change from the crystalline to a quasi-amorphous state (metamictization). Damage of this kind was observed in all anisotropic crystals; observable lattice disorder without phase change was obtained for MgO. None of the other cubic materials showed any appreciable change in their diffraction pattern, even at the highest dose. The annealing of the disorder in the lattice was correlated with release of the gas at low temperatures for all damaged substances. Significant gas releases at low temperatures were also obtained when much of the gas was in close proximity to the surface. Some other experimental conditions that cause gas release at low temperature are discussed. (auth)

27598 EFFECT OF NEUTRON RADIATION ON RECRYSTALLIZATION OF URANIUM. Dmitriev, V. D.; Ibragimov, Sh. Sh.; Nikol'shin, S. G. Dokl. Akad. Nauk SSSR, 165: 1065-8(Dec. 11, 1965). (In Russian).

The recrystallization process was studied in natural uranium as a function of neutron irradiation. The specimens were 99.8% pure with a diameter of 12 mm and a length of 70 mm. The neutron intensity was $2 \cdot 10^{13}$ neutrons per cm^2. The irradiated uranium rods were cut into sectors 4–5 mm thick. Recrystallization in these specimens was studied by microstructural and x-ray analysis and macrohardness measurements. Photomicrographs are given showing the structure of uranium specimens subjected to 50% deformation as a function of annealing temperature and holding time. Curves are given showing the hardness of deformed specimens as a function of annealing temperature before and after irradiation. Before irradiation, the specimens show a reduction in hardness (by 20–30 kg/mm^2) in the 450–550° region, and a considerable reduction (by 80–90 kg/mm^2) at temperatures above 600°. The first reduction in hardness is apparently caused by annealing of radiation hardening defects, while the second is due to recrystallization of the deformed specimens. It is found that irradiation by neutrons raises the temperature and retards the process of recrystallization in deformed uranium. The effects of fission products and redistribution of defects during irradiation are considered. (ATD)

27599 EFFECTS OF RADIATION ON THE OXIDATION AND HYDROGEN ABSORPTION OF ZIRCONIUM ALLOYS IN STEAM. Asher, R. C.; Davies, D.; Hall, A.; Kirstein, T. B. A.; Marriott, J. W.; White, P. J. (Atomic Energy Research Establishment, Harwell, Eng.). Electrochem. Technol., 4: 231-6(May-June 1966).

The oxidation of Zircaloy-2 and of Zr–2½% Nb alloy in steam at 300 to 340°C is enhanced by an average of eightfold under irradiation in a reactor at $\sim 3 \times 10^{13}$ n.cm^{-2} sec^{-1} (fast) + $\sim 5 \times 10^{8}$ R.hr^{-1} γ. The magnitude of the effect depends on the temperature, the radiation intensity, and whether pretransition or posttransition oxidation is involved. Limited evidence suggests that there is no effect on the proportion of hydrogen absorbed by the metal. It is concluded that the enhancement of oxidation is brought about by fast neutron damage in the oxide film, or possibly in the metal substrate. This view is supported by: experiments under ionizing radiation, in the absence of neutrons; observations on the effects of adding small amounts of hydrogen or oxygen to the steam; and a study of the postirradiation oxidation. A tentative mechanism is discussed. (auth)

27600 EFFECTS OF NEUTRON IRRADIATION AND VACUUM ANNEALING ON OXIDE FILMS ON ZIRCONIUM. Banter, J. C. (Oak Ridge National Lab., Tenn.). Electrochem. Technol., 4: 237-9(May-June 1966). (ORNL-P-1662).

Neutron-irradiated, anodized zirconium and thermally oxidized specimens were vacuum annealed. Reflection and transmission spectra of these specimens indicate that the irradiation affected neither the oxide films nor their rate of dissolution. However, the annealed films absorb light across the visible and ultraviolet spectral regions, apparently resulting from the production of defects by the film dissolution. Vigorous attack of the zirconium through annealed films by a solution of bromine in ethyl acetate supports the presence of defects. Unannealed specimens are not so attacked. Other results indicate that estimates of film thicknesses on annealed specimens, based on visual observation of interference colors, may be appreciably in error. The importance of both film formation and oxygen dissolution to the over-all oxidation mechanism is discussed. (auth)

27601 EFFECTS OF IRRADIATION AND ENVIRONMENT ON THE MECHANICAL PROPERTIES AND HYDROGEN PICKUP OF ZIRCALOY. Irvin, J. E. (Battelle Memorial Inst., Richland, Wash.). Electrochem. Technol., 4: 240-9(May-June 1966). (BNWL-SA-190).

Zircaloy-2 tensile specimens were irradiated at 290 and 60°C to exposures of 2.36×10^{21} nvt (>1 Mev). The greatest property changes occur in the material irradiated at 290°C and tested at room temperature, but the lowest ductility observed occurs at the 300°C test temperature. The mechanical properties are not adversely affected by changes due to out-of-reactor loop exposures for greater than 5500 hr. Crystallographic texture was established by means of a spiral-scanning, x-ray diffraction technique. The texture of these tubes reflected the variation in fabrication history. Corrosion rates were established by weighing and measuring all tensile specimens before and after exposure. Hydride content and orientation were determined by analytical and metallographic techniques. Corrosion rates were found to correlate with either time-at-temperature or neutron exposure, and were an order of magnitude greater than the equivalent out-of-reactor rates. A flux rate dependence was noted for a few critical tests. The amount of hydride pickup is proportional to the corrosion rate. The hydrides form preferentially along the second phase stringers which vary in orientation among the tubes examined. (auth)

27602 EFFECT OF IRRADIATION ON THE IMPACT PROPERTIES OF HYDRIDED ZIRCALOY-2 AND ZIRCONIUM–NIOBIUM ALLOY. Wood, D. S.; Winton, J.; Watkins, B. (United Kingdom Atomic Energy Authority, Culcheth, Eng.). Electrochem. Technol., 4: 250-8(May-June 1966).

The combined effect of irradiation and H_2 on the impact of cold-worked Zircaloy-2 and Zr–2½% Nb alloy in the annealed, cold-worked, and heat-treated conditions was studied. Materials containing up to 500 ppM H_2 were irradiated at 300°C to doses of 5×10^{20} n/cm^2. Both H_2 and irradiation impair the impact properties. Irradiation raised the transition temperatures of alloys containing 200 ppM H_2 by 100-200°C, but with 300 ppM H_2 the increase was only about 50°C. (auth)

27603 INFLUENCE OF NEUTRON IRRADIATION ON THE CREEP OF ZIRCALOY-2 AT 300 DEG C. Fidleris, V.; Williams, C. D. (Atomic Energy of Canada, Ltd., Chalk River, Ontario). Electrochem. Technol., 4: 258-67(May-June 1966).

Irradiation by fast neutrons enhances the creep rate of cold-worked, stress-relieved Zircaloy-2. The tests were carried out at 300°C under tensile stresses ranging from 11,000 to 30,000 lb/in.^{2} in fluxes of $5\text{-}10 \times 10^{12}$ neutrons/cm^2/sec (E > 1 Mev). In one test at 20,000 lb/in.^{2}, the irradiated specimen achieved a steady creep rate after 500 hr, while that of a corresponding laboratory control specimen decreased continuously. After 4000 hr, the in-reactor rate was the greater by a factor of 10. Transmission elec-

tron microscopy was used to study the deformation processes occurring in these specimens, and an assessment is made of the apparent influence of irradiation dislocation behavior. (auth)

27604 EFFECT OF NEUTRON IRRADIATION ON TENSILE PROPERTIES OF THE ZIRCONIUM–2.5 NIOBIUM ALLOY. Ells, C. E.; Fidleris V. (Chalk River Nuclear Labs., Ontario, Can.). Electrochem. Technol., 4: 268-74(May-June 1966).

Tensile specimens of Zr–2.5% Nb alloy were irradiated to integrated fast fluxes up to 3×10^{20} n/cm^2 at controlled temperatures between 50 and 375°C. The material was irradiated in four conditions, viz., slow cooled from each of the ($\alpha + \beta$)- and β-phases, and quenched (and aged at 500°C) from each of these phases. Tensile properties after irradiation were markedly dependent on the prior metallurgical condition. Possible mechanisms for the observed effects are discussed. (auth)

27605 ELECTRONIC MATERIALS: RESISTANCE TO RADIATION. Doman, D. R. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1350. Electro-Technol. (N. Y.), 75: No. 6, 38-41(June 1965).

Materials used in optical, structural, and electronic components were examined for post-irradiation effects with a ^{60}Co gamma source. Results for optical materials, differential transformers, transducer crystals, vidicon tubes, lamps, wires, and cables are reviewed and presented in tables. (M.C.G.)

27606 RADIATION-LUMINESCENCE PROPERTIES OF QUARTZOID GLASS. Botvinkin, O. K.; Mironova, A. L.; Zaporozhskii, A. I.; Ananich, N. I. Izv. Akad. Nauk SSSR, Neorg. Mater., 2: 173-7(Jan. 1966). (In Russian).

Quartzoid glasses, which were quartzified under various conditions, were studied in order to determine their radiation stability when exposed to ^{60}Co α radiation, the spectral characteristics of their luminescent emission when exposed to excitation with ultraviolet light at a wavelength of 253.7 mμ and the relative intensity of the main luminescence bands, and the thermoreactivity of the luminescent centers during deep cooling. The thermoluminescence spectra of irradiated quartzoid glasses were also studied. The glasses were found to have a high degree of stability to radiation and a luminescence 5 to 10 times weaker than that of quartz glasses, and to undergo a radiationless thermal bleaching. (ATD)

27607 ELECTRON SPIN RESONANCE STUDIES OF γ-IRRADIATED HIGH-SURFACE-AREA SILICA. I. IDENTIFICATION OF DEFECTS. Muha, G. M. (Esso Research and Engineering Co., Linden, N. J.). J. Phys. Chem., 70: 1390-8(May 1966).

Electron spin resonance (ESR) studies were made of the defects introduced in a high-surface-area silica by γ-irradiation. The ESR spectrum was analyzed in terms of contributions from four distinct types of defects in the glass structure. Two of these defects were thought to be formed in the silica network by the trapping of an electron in an oxygen vacancy. There was some evidence that ~10% of the oxygen vacancies have nearby hydroxyl groups. The remaining two defects were thought to consist of holes trapped in silicon–oxygen and boron–oxygen bonds. The evidence for the former assignment was not conclusive. The boron in the latter case occurred as an impurity in the silica. It was found to be trigonally coordinated in contrast to the tetrahedral coordination observed in other glasses. This result is explained in terms of the low concentration of network modifier present. The spectrum arising from the B–O defect is described by an axially symmetric spin Hamiltonian with $g_{||} = 2.0100$, $g_{\perp} = 2.0023$, $A_{||} = 1.40 \times 10^{-3}$, and $A_{\perp} = 1.25 \times 10^{-3}$ cm^{-1}. The relation between this B–O defect and the Al–O defect found in irradiated smoky quartz is briefly considered. (auth)

27608 ELECTRON SPIN RESONANCE STUDIES OF γ-IRRADIATED HIGH-SURFACE-AREA SILICA. II. EFFECT OF ADSORBED MOLECULES. Muha, G. M.; Yates, D. J. C. (Esso Research and Engineering Co., Linden, N. J.). J. Phys. Chem., 70: 1399-1405(May 1966).

Electron spin resonance techniques were used to study the effect of added gases on paramagnetic defects introduced in a high-surface-area silica by γ-irradiation. A previous study established the relation between these defects and the lines observed in the ESR spectrum of the irradiated solid. Hydrogen, deuterium, and methanol were chemisorbed at well-defined sites. The possible reactions involved are discussed. Carbon monoxide was chemisorbed to give one of two paramagnetic products depending on previous surface treatment. The sites for carbon monoxide absorption were not observed in the ESR spectrum of the irradiated silica before gas addition. Oxygen, nitric oxide, ammonia ethylene, and acetylene did not affect the ESR spectrum. The absence of an effect with the first two gases listed suggested that the sites observed by ESR are located in the bulk of the material. (auth)

27609 STRUCTURAL ANALYSIS OF FUEL GROWTH IN FUEL PLATES. Scavuzzo, R. J. (Univ. of Toledo, Ohio). Nucl. Eng. Design, 3: 199-204(1966).

Depletion of fissionable fuels is accompanied by a volumetric increase. In order to prevent coolant contamination, this volume increase must be withstood by the fuel-plate cladding. If the cladding is too thin large strains and resulting failure may take place. By defining an effective stress-strain curve of the fuel region, data from small irradiation specimens can be analyzed. Results, which can be extended to other plate geometries, can be used for two purposes: to insure cladding integrity and to determine distortion or instability of fuel plates caused by fuel growth. An example of an effective stress-strain curve derived from SM-2 irradiation test specimens is included. (auth)

27610 RADIATION EMBRITTLEMENT OF REACTOR PRESSURE VESSEL STEELS. Steele, L. E. (Naval Research Lab., Washington, D. C.). Nucl. Eng. Design, 3: 287-98(1966).

The problem of radiation embrittlement of reactor pressure vessel steels is considered within the framework of new NRL concepts of fracture analysis and in reference to the primary variables, steel composition, neutron exposure, and exposure temperature. (auth)

27611 COMPARISON OF NEUTRON EMBRITTLEMENT OF STEEL IN DIFFERENT REACTOR SPECTRA. Rossin, A. D. (Argonne National Lab., Ill.). Nucl. Struct. Eng., 1: 76-82(Jan. 1965).

A procedure was developed for measuring and reporting neutron exposure for radiation damage studies. The neutron spectrum shape is calculated and its magnitude determined by the reaction ^{54}Fe(n,p)^{54}Mn. A unit, called RDU, is used for reporting exposure. To test this procedure, steel specimens were irradiated in three very different reactor spectra. The exposures were expressed in RDU's and the resulting embrittlement compared. Satisfactory agreement was obtained. The procedure proved to be easy to use. A method for reducing a limited amount of irradiation data was devised to handle irradiations done in a facility where the neutron flux varied appreciably from place to place. (REIC)

27612 EFFECTS OF IRRADIATION ON MECHANICAL PROPERTIES OF NONFISSIONABLE CERAMICS. Clarke, F. J. P.; Wilks, R. S. (United Kingdom Atomic Energy Authority, Harwell, Eng.). pp 57-74 of Nuclear Applications of Nonfissionable Ceramics. Boltax, Alvin; Handwerk, J. H. (eds.). Hinsdale, Ill., American Nuclear Society, 1966.

Reactor irradiation displaces atoms from their normal lattice sites and eventually these cluster to form defects that can be seen in the electron microscope. These defects cause dimensional changes, which in turn have an effect on mechanical properties. Some of these phenomena are described for the oxides of magnesium, beryllium, and aluminum, and attention is drawn to problems that are raised in the more general field of ceramic materials. (auth)

27613 PROPERTIES OF MAGNESIUM, ALUMINUM, AND BERYLLIUM OXIDE COMPACTS IRRADIATED TO FAST-NEUTRON DOSES GREATER THAN 10^{21} NEUTRONS cm^{-2} AT 150, 800, and 1100 DEG C. Keilholtz, G. W.;

Lee, J. E. Jr.; Moore, R. E. (Oak Ridge National Lab., Tenn.). pp 133-48 of Nuclear Applications of Nonfissionable Ceramics. Boltax, Alvin; Handwerk, J. H. (eds.). Hinsdale, Ill., American Nuclear Society, 1966.

Fast-neutron damage to sintered compacts of MgO, Al_2O_3, and BeO was studied as a function of the neutron flux, dose, temperature, grain size, and density. The objectives were to establish limits for the use of these materials in nuclear reactors and to evaluate mechanisms of damage. Specimens were irradiated to neutron doses greater than 10^{21} n/cm^2 (>1 Mev) over the temperature range from 100 to 1100°C. Subsequent examination included visual observations, dimensional measurements, x-ray diffraction, micrographic inspection, and electron microscopy. The greatest difference in behavior was between BeO, with a hexagonal crystal structure, and MgO, which is cubic. The primary mode of damage to BeO was grain-boundary separation, caused by anisotropic crystal expansion. The degree of damage increased with increasing dose and decreased with increasing temperature. The cubic structure of MgO precluded anisotropic expansion, and the lattice parameter expansion was very small compared with that of BeO; accordingly, irradiated samples exhibited virtually no grain-boundary separation. Transgranular fracture was severe, but, unlike BeO, the amount of fracturing appeared to be random with respect to neutron dose, and it increased with increasing temperature. The randomness of fracture can be explained by postulating that a minimal neutron dose can weaken the crystals enough to permit the propagation of cracks from randomly distributed sites within MgO compacts. It is likely that fracturing at high temperatures is promoted by thermal stress. The lattice parameter expansion of the hexagonal α-Al_2O_3 crystal was less than that of BeO, and the expansion was nearly isotropic. The similarity of the effects of fast neutrons on MgO and Al_2O_3 suggested that these two oxides are damaged through the same mechanisms. (auth)

27614 EFFECT OF ENVIRONMENT ON CERAMIC INSULATORS FOR NUCLEAR THERMIONIC APPLICATIONS. Davis, Monte V. (Univ. of Arizona, Tucson). pp 229-46 of Nuclear Applications of Nonfissionable Ceramics. Boltax, Alvin; Handwerk, J. H. (eds.). Hinsdale, Ill., American Nuclear Society, 1966.

The effects of high temperature and high radiation fields on the physical properties of ceramic insulators were investigated in radiation fields to approximately 5×10^6 R/h and at temperatures to approximately 2000°K. The electric conductivity is shown to obey an equation of the form $\sigma(P,T) = \sigma'(T) + APT^{-\frac{1}{2}} \exp(-u/kT)$, where σ' is the temperature-dependent conductivity in the absence of a radiation field, u is the excitation energy for trapped electrons resulting from the radiation field, P is the specific power of the reactor in watts per liter, T is the absolute temperature, and A is a normalizing constant. The thermal conductivity obeys the theoretical T^{-1} relationship, and no measurable effect resulting from the radiation fields in the reactor to 5×10^6 R/h was observed. It was inferred that the high density of conduction electrons can materially affect the electrical conductivity of materials at low temperatures. However, this density of electrons is so low that the electrons cause no measurable effect on the thermal conductivity where the transport of energy is by lattice waves. An analysis is included of the change in electrical conductivity with the impressed radiation field assuming a shift in the Fermi level within the material. This leads to results that are also in agreement with the experiment. The dielectric breakdown under high voltages was investigated and found to be sensitive to both the electrical and thermal conductivity of the material. Based on the investigations it was concluded that BeO_2 and Al_2O_3 are the best insulators for in-core thermionic reactor systems. (auth)

27615 SHIELDING APPLICATIONS FOR CERAMICS. Galbreath, W. W. Jr. (Virginia Kyanite Corp., Lynchburg). Mong, B. A. pp 471-87 of Nuclear Applications of Nonfissionable Ceramics. Boltax, Alvin; Handwerk, J. H. (eds.). Hinsdale, Ill., American Nuclear Society, 1966.

Several ceramic products are used in the nuclear industry for shielding purposes. If exposure to reactivity is relatively low, conventional concretes and soda-lime glasses are adequate. To meet the requirements of exposure to high-level reactivity, such as that in a nuclear reactor, some existing materials were modified and new materials were developed. Because of their low cost, concretes are widely used as structural materials and as biological shielding. Glasses of various kinds are routinely used to view operations or processes inside a structure. Ceramic shielding is very important in the reprocessing of fuel elements and in the storage of spent elements. Certain ceramic materials are mixed with radioactive wastes to minimize the hazards of waste storage and disposal. (auth)

27616 BEHAVIOR OF SOME PHOTOGRAPHIC MATERIALS EXPOSED TO RADIATION IN THE 8-ANGSTROM REGION. Szilagyi, Zsolt (Philips Labs., Briarcliff Manor, N. Y.); Blackman, Elliot. Photogr. Sci. Eng., 10: 111-13(Mar.-Apr. 1966).

In connection with a rocket flight to obtain an image of the sun in the 8- to 20-Å region, an evaluation of the sensitometry of several photographic materials was made. Major emphasis was given to the testing of 35-mm films, of which several fast uv and x-ray emulsions were exposed to radiation from x-ray sources in the 8-Å region to determine the magnitude, if any, of the reciprocity failure. Reproducibility of the results for Ilford Industrial G x-ray film is illustrated in terms of density vs the total number of photons incident/cm^2 of the emulsion. Uncertainty in the transmission of each successive window decreased with the number of layers, since the monitoring counter had the same filter thickness as the window corresponding to the lowest density exposure on a test strip. For small fluctuations in exposure, the maximum density variance was observed on the straight line portion of the curve, and the greatest deviation, therefore, in the higher density regions. Sensitometric curves were also obtained for various other films. Emphasis was placed on the calibration of the toe and straight line regions of the characteristic curves. The results of the examinations of the reciprocity failure for a two order of magnitude variation in exposure time (3 and 300 sec) are given. The measurements obtained for these fast emulsions revealed no appreciable evidence of the existence of reciprocity failure for 8-Å x rays. This may be explained in terms of the rate of electron release in grains caused by the absorption of photons, which is believed to be higher for x rays than for less energetic light quanta. (BBB)

27617 PRODUCTION RATES OF ELECTRICAL RESISTIVITY IN COPPER AND ALUMINUM INDUCED BY ELECTRON IRRADIATION. Iseler, G. W.; Dawson, H. I.; Mehner, A. S.; Kauffman, J. W. (Northwestern Univ., Evanston, Ill.). Phys. Rev., 146: 468-71(June 10, 1966).

Polycrystalline copper and aluminum were bombarded below 6°K with monoenergetic electrons with energies in the range 0.15 to 2.1 Mev. The production rates of electric resistivity were measured and the threshold energies for atom displacement were found to be 19 ± 3 ev for copper and 16 ± 2 ev for aluminum. The results indicate that the probability function for atom displacement is not a single step for either copper or aluminum. More complex functions are considered, and multiple displacements appear to be important for both metals for the energy range studied. (auth)

27618 ELECTRON-INDUCED ATOMIC DISPLACEMENTS NEAR THRESHOLD IN THIN SINGLE-CRYSTAL FOILS. Gettys, W. Edward (Clemson Univ., S. C.). Phys. Rev., 146: 480-5(June 10, 1966). (TID-22729).

The cross section for atomic displacement produced by electron beams is obtained in an approximate manner under the following conditions: (a) The electron beam is centered about a major crystallographic direction coinciding with a minimum in the threshold energy surface. (b) The electron beam has angular dispersion due to finite collimation and/or multiple scattering. (c) Energy degradation of the electron beam is accounted for. The displacement cross section is found to be a sensitive function of

the angular beam spread and the crystal parameter describing the threshold-energy surface valley. An average cross section is computed for a number of cases and compared with available experimental data for copper. (auth)

27619 IRRADIATION AND ANNEALING OF SILICON PLANAR TRANSISTORS. **Baldinger, E.; Lenzlinger, M. (Univ., Basel). Solid-State Electron., 9: 287-302(Apr. 1966).**

A study was made of the effects of irradiation by fast neutrons (14 Mev) and γ rays (^{60}Co) on collector cutoff current I_{CBO} and base current I_B at low current densities on silicon planar transistors. With neutron irradiation I_{CBO} and I_B increased linearly, while with γ irradiation saturation occurred. The temperature dependence of I_{CBO} between 9 and 89°C showed that the recombination level of the induced defects lies in the middle of the forbidden gap. Moreover, γ irradiation introduced slow surface states, which were responsible for an observed I_{CBO} drift. The measured base currents can be described by the equation $I_B = \text{const} \exp(E_b/kT) \cdot \exp(qV_{EB}/nkT)$, where E_b = activation energy of I_B, q = magnitude of electronic charge, V_{EB} = emitter-to-base voltage, and n = exponent in base current characteristics. It was observed that n = 1.27; E_b = 0.95 ev after neutron irradiation and n = 1.8; E_b = 0.68 ev after γ irradiation. The result of neutron irradiation cannot be explained by existing theories. It was concluded that neutrons induce defects within the volume of the transistors, while the consequences of γ irradiation are explained by surface effects. All of the observed radiation damage can be completely annealed. Annealing for damage proceeds in one stage at 100°C and that for neutron damage in two stages at 120 and 270°C, respectively. For the first annealing stage of neutron-irradiated transistors, the activation energy of defect annealing was: $E_a = 1.53 + 0.07$ ev. In many cases certain properties of n-p-n transistors may be improved by irradiation and annealing. (BBB)

27620 IRRADIATION EXPERIMENTS ON NUCLEAR MATERIALS. (PROPERTIES EXAMINED AND SUITABLE DEVICES). **Motoc, C. (Inst. of Atomic Physics, Bucharest). Studii Cercet. Fiz., 17: 1139-49(1965). (In Rumanian).**

Newly developed materials, to be used as fuel, cladding or moderator, must be tested under conditions to which they will be subjected in an operating reactor. The methods used for such irradiation experiments with capsule-type devices are described. During the tests, information is collected on dimensional, density and microstructural changes, fission products formed, on the corrosion phenomena, thermal conductivity and the compatibility of the fuel with its cladding. Certain materials must be irradiated at low temperatures. In some tests, the specimens are placed in liquid sodium in order to ensure good thermal contact. Creep tests involve in-reactor and cold measurements. For structural materials tests, special devices are available to compare the mechanical and other properties before and after exposure. These tests usually include determination of stress-strain curve, yield strength, rupture strength, elongation, etc. Electric resistivity, thermal conductivity, and dynamic modulus of rigidity are usually determined during the exposure; the devices used usually allow ambient temperatures in the 80 to 600°C range. Moderator materials are usually subjected to measurements of dimensional, structural, mechanical and thermal changes. In some cases, graphite specimens have been installed directly on the graphite blocks of the testing reactor. (TTT)

27621 QUANTITATIVE DETERMINATION OF LATTICE DISTURBANCES FROM THEIR INFLUENCE ON THE CIRCULAR POLARIZATION OF QUARTZ. **Buchholz, H. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Z. Naturforsch., 21a: 316-23(Mar. 1966). (In German).**

Both lattice defects and color centers (which produce the A-band at 470 mμ) in irradiated quartz are shown to contribute to the change in the rotation of the plane of polarized light. A quantitative relationship between the concentration of the color centers and the change in the angle of rotation is described. In addition, the relation between the concentration of the lattice defects and the change in rotation was determined and compared to the predictions of theory. To obtain these results an apparatus was constructed that allows small changes in the angle of rotation to be measured. ESR measurements of irradiated quartz were carried out, too. The oscillator strength of transitions leading to the 470 mμ absorption of γ-irradiated quartz was found to be equal to 0.0064. The yield of lattice defects amounted to 74 cm^{-} (i.e., defects per unit volume and fast neutron dose.) The average energy required to produce one lattice defect was found to be equal to 170 ev. The multiplication factor between primary and secondary dislocation was equal to 180. (auth)

27622 PENETRATION DEPTH OF 70-kev KRYPTON IONS IN TUNGSTEN SINGLE CRYSTALS. **Herrmann, H. (Technische Hochschule, Munich); Lutz, H.; Sizmann, R. Z. Naturforsch., 21a: 365-6(Mar. 1966). (In German).**

Investigations were carried out to determine the origin of the supertail found in the irradiation of tungsten single crystals with 70-kev krypton ions. The results showed that the supertail is formed first at 78°K after irradiation during heating to room temperature. It is caused by the diffusion of approximately 10^{-2}% of the bombarding Kr ions. The activation of the diffusion was estimated from the studies at 78°K and room temperature. The activation energy lies in the interval $0.3 < Q < 0.8$ ev. This relatively low value of Q corresponds to the fact that the diffusing Kr atoms are found in the interstitial lattice plates. (J.S.R.)

PHYSICS

General

27623 (LRP-24/66) ETUDE DE LA PRECISION DES MESURES EN SPECTROSCOPIE PHOTOGRAPHIQUE. (Study of the Precision of Measurements in Photographic Spectroscopy). Durand, J. (Laboratoire de Recherches sur la Physique des Plasmas, Lausanne (Switzerland)). Apr. 1966. 16p. Dep. mn.

Light intensity measurements using photographic plates can give large errors when the development is carried out according to the instructions of the manufacturer (Eberhard's effect). This work determines experimental conditions under which good results can be obtained. It appears that the photographic method can give results with an average accuracy of 10%. (auth)

27624 (TID-22956) QUARTERLY PROGRESS REPORT NO. 81 [ON ELECTRONICS]. Zimmermann, H. J.; Harvey, G. G. (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics). Apr. 15, 1966. Contract AT(30-1)-905. 274p. (RLE-QPR-81). Dep. mn. CFSTI $6.00 cy, $1.50 mn.

Research and development progress is reported in three sections. An abstract was prepared for one section. Sections for which no abstracts were prepared are concerned with general physics investigations and communications engineering. (J.R.D.)

For an abstract of the individual section see: 28497.

27625 MEASUREMENT OF MAGNETIC FIELDS AT LOW TEMPERATURES USING HALL GENERATORS. Hlasnik, I.; Chovanec, F.; Polak, M. Cryogenics, 6: 89-93(Apr. 1966).

An analysis of the parameters which influence the properties of Hall generators at low temperatures, and which determine the choice of appropriate semiconducting materials with given requirements for use as Hall generators is given. Indium antimonide and germanium generators are compared with regard to maximum sensitivity, small temperature dependence, and good linearity. Also presented are experimental results on indium antimonide Hall generators at 4.2°K and in fields up to 50 kG. (auth)

27626 RAY STATISTICS IN PLANE-STRATIFIED MEDIUM WITH RANDOM INHOMOGENEITIES. Komissarov, V. M. (Inst. of Acoustics, Academy of Sciences, USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 9: 292-301 (1966). (In Russian).

The process of wave propagation in a medium with regular and random inhomogeneities is described using the Fokker-Planck equation. The spatial-angular function of the ray distribution is found. The fluctuations of incidence angles and of ray displacements are calculated. The conditions of applicability of this analysis are explained. (auth)

27627 ON A THEOREM BY LAGRANGE. Kurth, Rudolf. Koninkl. Ned. Akad. Wetensch., Proc., Ser. B, 69: 240-50(1966).

The solution of the three-body problem according to Lagrange is extended to regular configurations of more than three particles. The three-body solution is such that at any moment the three gravitating particles form an equilateral triangle. (J.F.P.)

27628 RESPONSE CORRECTIONS IN DIGITIZED STATISTICAL SPECTRA. Slavinskas, D. D.; Kennett, T. J.; Prestwich, W. V. (McMaster Univ., Hamilton, Ont.). Nucl. Instrum. Methods, 41: 341-7(1966).

An expression is derived for inverse matrix elements of a certain class of infinite response matrices. The class is limited to response functions which are fixed in shape or have a slow variation with energy. Possible application to resolution corrections is discussed with consideration of statistical deviations present in the spectrum. (auth)

27629 MEASUREMENT OF PHOTON BUNCHING IN A THERMAL LIGHT BEAM. Morgan, B. L. (Imperial Coll. of Science and Tech., London); Mandel, L. Phys. Rev. Lett., 16: 1012-15(May 30, 1966).

The distribution of time intervals between successive photon counts of an illuminated photomultiplier is measured in the range of 1.4 to 10 nsec, for the light from a low-pressure ^{198}Hg discharge lamp. The measurements lead to a spectral width of the blue ^{198}Hg line of about 200 Mc. (B.G.D.)

27630 AN EXACTLY SOLVABLE MODEL FOR BROWNIAN MOTION. I. DERIVATION OF THE LANGEVIN EQUATION. Ullersma, P. (Rijksuniversiteit, Utrecht). Physica, 32: 27-55(Jan. 1966).

The motion of an elastically bound particle, linearly coupled with a bath of N harmonic oscillators is calculated exactly. The interaction is assumed to be rather weak and to vary slowly as function of the frequencies of the oscillators. The bath is chosen at the initial time in thermal equilibrium. It turns out that in the limit $N \rightarrow \infty$ the motion of the particle is governed by the Langevin equation of the damped harmonic oscillator. The solution of this Langevin equation has the same behavior as in the conventional theory of Brownian motion after a transient time τ_t. In the quantum mechanical case an additional transient time appears, $\tau_q = \hbar/kT$. The theory is applied to an elastically bound electron in an electromagnetic field. Two cases are considered. First the square of the vector potential is discarded and the electron has an extended charge distribution. In the other case a point electron is considered and its mass is renormalized. The familiar expression for the radiation damping constant is found. (auth)

27631 AN EXACTLY SOLVABLE MODEL FOR BROWNIAN MOTION. II. DERIVATION OF THE FOKKER-PLANCK EQUATION AND THE MASTER EQUATION. Ullersma, P. (Rijksuniversiteit, Utrecht). Physica, 32: 56-73(Jan. 1966).

As in previous work an elastically bound particle, linearly coupled with a bath of small oscillators, is considered. At the initial time the bath is chosen in thermal equilibrium with temperature T. In the classical case the distribution function for the momentum and displacement of the particle is calculated exactly. It turns out that under the same assumptions needed for the derivation of the Langevin equation, this distribution function satisfies a Fokker-Planck equation for times large compared to a transient time τ_t. In the quantum mechanical case the probability of finding the particle at time t in an eigenstate of its unperturbed hamiltonian is also calculated exactly. If in addition to the above-mentioned assumptions the phases of the initial state of the particle are chosen randomly, this probability satisfies a master equation for times large compared to τ_t and $\tau_q = \hbar/kT$, the quantum statistical transient time. The main point in this treatment is that perturbation theory is not applied and that therefore averaging over the bath of small oscillators and over the phases of the state of the particle is only needed at the initial time. (auth)

27632 AN EXACTLY SOLVABLE MODEL FOR BROWNIAN MOTION. III. MOTION OF A HEAVY MASS IN A LINEAR CHAIN. Ullersma, P. (Rijksuniversiteit, Utrecht). Physica, 32: 74-89(Jan. 1966).

The theory on Brownian motion developed previously is applied to a linear chain with harmonic coupling between nearest neighbors. All masses are equal except for one which is heavy compared to the others. This heavy particle behaves as a Brownian particle, which is not subject to an external field. The Langevin equation and the Fokker-Planck equation are derived for the classical and quantum mechanical case, again without applying perturbation theory. It turns out that in addition to the transient times there exists a time τ_1, beyond which these equations lose their

validity. This limit time is due to the fact that the frequency spectrum has a finite maximum. (auth)

27633 AN EXACTLY SOLVABLE MODEL FOR BROWNIAN MOTION. IV. SUSCEPTIBILITY AND NYQUIST'S THEOREM. Ullersma, P. (Rijksuniversiteit, Utrecht). Physica, 32: 90-6(Jan. 1966).

By means of an exactly solvable model, treated previously, the relation between the microscopic and macroscopic susceptibility is discussed. Furthermore, the limits of the validity of Nyquist's theorem are given. (auth)

27634 DISTORTION OF PULSE-HEIGHT SPECTRA BY PILE-UP EFFECT. Williamson, J. H. (Univ. of British Columbia, Vancouver, Can.). Rev. Sci. Instrum., 37: 736-9(June 1966).

A method is developed to compute the distortion of pulse-height distributions by the pile-up effect for arbitrary spectra and pulse shapes. The distorted spectra can be processed by an iterative method to reproduce the original distribution. Results are given for pulses shaped by resistors and capacitors or by short circuited delay lines. The best pulse-shaping network is a simple modification of the double-delay-line clipping amplifier. (auth)

27635 FOCUSING PROPERTIES OF SPECIAL 2-POLE FIELDS FOR ALKALINE ATOM BEAMS AND THEIR USE FOR THE PRODUCTION OF POLARIZED ELECTRONS. Regenfus, G. Munich, Univ., 1964. 55p. $2.00 Gmelin, AED-Diss. 64-1059.

It is demonstrated that high intensities of polarized alkaline atoms can be produced by means of a special dipole field. Focusing and dispersion of this field are discussed. (Gmelin Inst.)

27636 SOME ASPECTS OF NON-EQUILIBRIUM THERMODYNAMICS IN THE PRESENCE OF A RADIATION FIELD. Thomas, Richard N. Boulder, Colo., University of Colorado Press, 1965. 220p.

Radiative transport and spectroscopic diagnostics of a gaseous ensemble and the effects of the assumptions of local and nonlocal thermodynamic equilibrium are considered, with applications to astrophysics and plasma physics. Discussions are included of the empirical methodology for specifying the observational state, the theoretical approach to the intermediate parameters, the small-perturbation vs the general rate-process approach to the nonlocal-thermodynamic-equilibrium configuration for a diffuse radiating gas, the radiative transfer problem for atmospheric self-emission, the relation of the local energy content of the gas to its spectroscopic state, and the spectroscopic diagnostic methodology associated with the nonlocally controlled situation in a diffuse gas. (M.J.T.)

27637 XII COLLOQUIUM SPECTROSCOPICUM INTERNATIONALE EXETER, 11–17 JULY 1965. (12th International Spectroscopy Conference, Exeter, England, July 11–17, 1965). London, Hilger and Watts, Ltd., 1965. 718p. (CONF-650726).

Eighty-four papers on spectroscopy are presented. Topics discussed are emission spectroscopy of nonconductors, sources with arc or plasma excitation, ultraviolet and visible absorption spectroscopy, atomic absorption and flame spectroscopy, sources with spark and laser excitation, techniques in molecular spectroscopy, molecular mass spectroscopy, x ray fluorescence spectroscopy, emission spectroscopy of conductors, infrared absorption spectroscopy, emission spectroscopy (general), spark-source mass spectroscopy, and evaluation of spectra. (B.G.D.)

27638 EINLADUNG ZUR PHYSIKERTAGUNG FRANKFURT/MAIN-HOECHST, 4-9 OKTOBER 1965. (Physical Sciences Conference, Frankfurt/Main-Hoechst, October 4-9, 1965. Agenda and Abstracts. Munich, Deutsche Physikalische Gesellschaft e.V., 1965. 100p. (In German). (CONF-651030-(Abst.)).

27639 PHYSIKERTAGUNG 1965 FRANKFURT (M)-HOECHST, OKT. 4-9. PLENARVORTRAEGE. (Physical Sciences Conference, Frankfurt/Main-Hoechst, October 4-9, 1965. Plenary Sessions). Stuttgart, B. G. Teubner Verlagsgesellschaft mbH, 1965. 551p. (CONF-651030-(Vol. 2)).

Nineteen papers presented at the plenary sessions are included. Separate abstracts were prepared for eight. One was previously abstracted for NSA; see 20: 4773. The remaining papers deal with the physics of thin films, development of stars, high polymers, theory of metals, energy conversion in macromolecular systems, the eight-fold way, acoustics, semiconductor techniques, and information theory. (L.B.S.)

For abstracts of individual papers see: 27876, 28027, 28028, 28080, 28159, 28160, 28435, and 28669.

27640 PHYSIKERTAGUNG 1965 FRANKFURT (M)-HOECHST, OKT. 4-9. VORABDRUCKE VON KURZFASSUNGEN DER FACHBERICHTE. (Physical Sciences Conference, Frankfurt/Main-Hoechst, October 4-9, 1965. Preprints of Invited Papers). Stuttgart, B. G. Teubner Verlagsgesellschaft mbH, 1965. 236p. (In German). (CONF-651030-(Vol.1)).

Forty-five papers are included in Vol. 1; separate abstracts were prepared for 19. The remaining papers deal with topics in electronics, acoustics, use of thin films, solid state physics, high-polymer physics, and direct energy conversion. (L.B.S.)

For abstracts of individual papers see: 26983, 27390, 27711, 28029, 28030, 28161, 28162, 28211, 28255, 28256, 28436–28441, and 28670–28672.

Accelerators

Refer also to abstracts 27282, 28267, 28286, 28401, and 28697.

27641 (BNL-10169) LONGITUDINAL INSTABILITY RISE RATES. Pease, Robert L. (Brookhaven National Lab., Upton, N. Y.). Mar. 22, 1966. Contract AT(30-2)-Gen-8. 22p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Longitudinal instabilities in cyclic particle accelerators start when the number of particles in the beam is somewhat less than the number usually quoted, but increase at a rate somewhat slower than the rate usually quoted. Correction factors are found for both negative mass (above transition) and resistive (below transition) cases. Approximate universal graphs are presented for ease in computation. (auth)

27642 (BNL-10222) RF SEPARATION TECHNIQUES AT A SUPER-HIGH-ENERGY ACCELERATOR. [PART] II. Sandweiss, J. (Brookhaven National Lab., Upton, N. Y.). Apr. 14, 1966. Contract AT(30-2)-Gen-16. 17p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

In an earlier report on r-f separation techniques at super-high-energy accelerators (R-F1), certain aspects of r-f beams with design momentum up to 500 Bev/c were considered. Particular attention was given to the ultimate limitations imposed by achievable beam transmission. These considerations are further developed and the effects of various sources of background and image broadening are discussed. (M.O.W.)

27643 (BNL-10236) DECATURN BEAM EXTRACTION FROM SYNCHROTRONS. Reich, K. H. (Brookhaven National Lab., Upton, N. Y.). Apr. 6, 1966. Contract AT(30-2)-Gen-16. 31p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

Three stages of acceleration are customary in present synchrotrons; more stages are likely to be used in the multi-hundred-Bev accelerators. One or two of these additional stages may well be a "booster" synchrotron, either of the fast-cycling or the slow-cycling type. In the latter case, the beam must be extracted over something like 5 to 30 turns. For this "decaturn" extraction, two methods were considered: reverse multiturn injection and resonant extraction. Some of their properties are compared, including the extraction efficiency, beam emittance, dilution in phase space, and hardware requirements. (M.O.W.)

27644 (JINR-P-2657) VREMENNAYA STRUKTURA PUCHKOV CHASTITS, VYVEDENNYKH IZ SINKHROTSIK-

LOTRONA OIYAI. (The Time Structure of Particle Beams Extracted From JINR Synchrocyclotron). Zinov, V. G.; Medved, S. V.; Ozerov, E. B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1966. 14p. Dep. mn.

The curve shapes for time intensity distribution were measured for particle beams extracted from the Dubna synchrocyclotron. The time structure due to accelerating voltage frequency was measured for the same beams. It is shown that secondary beams slowly extracted from our synchrocyclotron have no r-f structure. (auth)

27645 (KFK-403) STUDIES ON CROSSBAR AND SLOTTED IRIS STRUCTURES FOR A PROTON LINEAR ACCELERATOR. Bauer, W.; Eschelbacher, H.; Kuntze, M. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Feb. 1966. 44p. Dep. mn.

An investigation of r-f structures for proton linacs was made. A slotted iris structure was designed for an operating frequency of 760 MHz. A crossbar structure was designed for an operating frequency of 357 MHz. Calculations to determine the performance of these two structures are presented. (M.O.W.)

27646 (NP-15878) EXPERIMENTELLE UNTERSUCHUNGEN AN EINEM 12 Mev-SYNCHROTRON. (Experimental Study of a 12 Mev Synchrotron [Thesis]). Mlitz, Peter (Freie Universitaet, Berlin (West Germany). I. Physikalisches Institut). 1963. 31p. Dep. mn.

The results of the measurements obtained on a 3-Mev betatron and a 12-Mev synchrotron are reported. The studies described are limited essentially to the synchrotron operation whose principle is first briefly explained. For the optimum frequency of the accelerating high-frequency voltage a value of 570 mhz was obtained from the measurements. The efficiency in the transition from betatron to synchrotron operation amounts at this frequency from 30 to 40%. The effect of the betatron phase of acceleration, the HF power and pulse length, the magnetic current, and the target preparation on the synchrotron emission was investigated. The experimental results were discussed with respect to the values to be expected from theory and compared with the results reported in the literature. The high frequency installation of the synchrotron and the radiation measurement device are discussed in detail. (tr-auth)

27647 (NP-16008) O SILAKH USKORYANUSHCHIKH MALYE PLAZMENNYE SGUSTKI V VOLNOVODNYKH POLYAKH. (Forces Accelerating Small Plasma Clusters in Waveguide Fields). Levin, M. L.; Muratov, R. Z. (Akademiya Nauk SSSR, Moscow. Radiotechnicheskii Institut). 1963. 31p. Dep. mn.

The general formula for accelerating fields, operating on small plasma clusters in waveguide fields, was derived. Cases of good-conducting clusters with spheroid form in waveguides of circular and rectangular cross section were examined in detail. (tr-auth)

27648 (NP-16009) SISTEMA PITANIYA MAGNITA BEZZHELEZNOGO SINKHROTRONA BSB. (Power Supply System to the Magnet of an Air-Cored Synchrotron BSB). Livshits, A. A.; Nelidov, A. B.; Samoilov, I. M.; Sokolov, A. A. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). 1965. 14p. Dep. mn.

A description is given of the magnet power supply system of the pulsed BSB synchrotron. The system operates in inductive load of 350 cm, current pulse of special form with acceleration time of only 1.5 msec, and maximum value of the current up to 10^6 amp. (tr-auth)

27649 (NP-16011) KHARAKTERISTIKI MAGNITNOGO POLYA BEZZHELEZNOGO SINKHROTRONA BSB. (Magnetic Field Characteristics of an Air-Cored Synchrotron BSB). Nelidov, A. B.; Samoilov, I. M.; Sokolov, A. A. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). 1965. 17p. Dep. mn.

The results of the measurement of the magnetic field of the air-cored single-coil BSB synchrotron during supply with sinusoidal pulsed current with acceleration time of ~10^{-3} sec were reported. (tr-auth)

27650 (NP-16013) SOMOSOGLASOVANNAYA ZADACHA DLYA ELECTRONNOGO POTOKA, FOKUSIRUEMOGO MAGNITNYM POLEM. (Self-Consistent Problem for Electron Flux Focused by Magnetic Field). Vlasov, A. D. (Akademiya Nauk SSSR, Moscow. Radiotekhnicheskii Institut). 1963. 12p. Dep. mn.

The relations between the distribution of the charge density and the distribution of particles on different trajectories in non-laminar axial symmetry with electron currents, focused by longitudinal magnetic fields, were examined. (tr-auth)

27651 EURATOM'S SHORT PULSE-LONG PULSE LINEAR ELECTRON ACCELERATOR. Azam, G. (CSF-Compagnie Generale de Telegraphie Sans Fil, Orsay, France). Ann. Radioelec., 21: 151-62(Apr. 1966). (In French).

An accelerator was built for Euratom for the purpose of neutron measurements. It is installed at Geel (Belgium). It is a linear electron accelerator of the iris-guide type working in S band at a frequency of 3000 Mc/s. (auth)

27652 PRINCIPAL PROPERTIES OF NONLINEAR FOCUSING. Vecheslavov, V. V.; Orlov, Yu. F. At. Energ. (USSR), 20: 112-17(Feb. 1966). (In Russian).

Nonlinear focusing in a symmetrical magnetic field was studied. The dimensions of the primary regions of stability were determined with consideration of the nonlinear oscillations. The effect of r-z resonances and the preservation of stability during adiabatic attenuation by means of mutual self-phasing for r and z were investigated. It was established that the mutual self-phasing arises in the area of r-z resonances. (D.C.W.)

27653 GAS SUPPLY SYSTEM FOR THE ION SOURCE IN AN ELECTROSTATIC GENERATOR. Androsov, A. V.; Osetinskii, G. M.; Chepurchenko, I. A. At. Energ. (USSR), 20: 165-6(Feb. 1966). (In Russian).

A gas supply system for an ion source in an electrostatic generator is described which uses electromagnetic valves in the gas cylinder and needle valves on top of the cylinder. (G.O.Y.)

27654 STARTUP OF A B-3M SYNCHROTRON AS INJECTOR FOR A POSITRON-ELECTRON STORAGE RING. Budker, G. I.; Kiselev, A. V.; Kon'kov, N. G.; Naumov, A. A.; Nifontov, V. I.; Ostreiko, G. N.; Panasyuk, V. S.; Petrov, V. V.; Yudin, L. I.; Yasnov, G. I. At. Energ. (USSR), 20: 206-10(Mar. 1966). (In Russian).

A method of tuning a synchrotron with internal single-spiral injection and single-spiral ejection of the electrons is described. (tr-auth)

27655 PHASE INSTABILITY OF INTENSIVE ELECTRON BEAMS IN A STORAGE RING. Auslender, V. L.; Karliner, M. M.; Naumov, A. A.; Popov, S. G.; Skrinskii, A. N.; Shekhtman, I. A. At. Energ. (USSR), 20: 210-13 (Mar. 1966). (In Russian).

Radial-phase self-oscillations in a storage ring were observed with a high beam current. The stability conditions were derived for the case of arbitrary frequencies of the characteristics of the accelerating system. The interaction of the beam with the accelerating system and with other elements of the vacuum chamber was calculated in harmonic frequencies of the cluster cycle. Some results of an experimental investigation of the self-excitation of phase oscillations are presented. (tr-auth)

27656 EFFECTS OF ELECTROMAGNETIC INTERACTIONS IN BEAM-PARTICLE COLLISIONS. Derbenev, Ya. S.; Mishnev, S. I.; Skrinskii, A. N. At. Energ. (USSR), 20: 217-20(Mar. 1966). (In Russian).

The effect of the electromagnetic field of the colliding bunch on the betatron oscillation of particles of the small bunch was investigated. (tr-auth)

27657 SYSTEM FOR CONTROL AND MEASUREMENT OF ELECTRON BEAM PARAMETERS IN VEP-1 ELECTRON-ELECTRON STORAGE RING. Zinin, E. I.; Koro'beinikov, L. S.; Kulipanov, G. N.; Lazarenko, B. L.; Matveev, Yu. G.; Popov, S. G.; Skrinskii, A. N.; Starodubtseva, T. P.; Tumaikin, G. M. At. Energ. (USSR), 20: 220-3 (Mar. 1966). (In Russian).

A brief description is given of the system that was developed for the measurement of the parameters of the electron beam in the VEP-I electron-electron storage ring. The method used for the monitoring of the beam parameters and for beam control is described. (tr-auth)

27658 INFLUENCE OF RESISTIVE WALLS ON BEAM DIMENSIONS AND SHAPE OSCILLATIONS IN ACCELERATORS AND STORAGE RINGS. Balbekov, V. I.; Kolomenskii, A. A. At. Energ. (USSR), 20: 270-1(Mar. 1966). (In Russian).

An algorithm for establishing the influence of resistive walls, on beam dimensions and shape oscillations in accelerators and storage rings is given. (G.O.Y.)

27659 USE OF SLOW-CYCLING SYNCHROTRONS IN INJECTION SYSTEMS. CERN Cour., 6: 63-7(Apr. 1966).

The CERN synchrotron improvement program is considered. This improvement includes the provision of two very large bubble chambers, and the improvement of the synchrotron itself by increasing the intensity of protons accelerated per second. This can be accomplished by increasing the repetition rate, which is the number of pulses per second, and by increasing the number of protons accelerated in each pulse, which is primarily effected by the quality and energy of the proton beam injected into the synchrotron. Various injection systems are discussed especially the Twin Accelerator Storage Ring (TART). (J.F.P.)

27660 STUDY OF THE VARIATION OF THE COMPOSITION OF AN ION BEAM FURNISHED BY A HIGH-FREQUENCY SOURCE OPERATING WITH HYDROGEN WITH DIFFERENT PRESSURES. Devienne, F.-Marcel; Roustan, Jean-Claude (Laboratoire Mediterraneen de Recherches Thermodynamiques, Nice). Compt. Rend., Ser. B, 262: 616-19(Feb. 28, 1966). (In French).

The percentage of H_3^+ ions was studied as a function of the pressure of the ion source using two measurement methods. The first method is a time-of-flight method and in the second the analysis of the ion beam is made by means of an electromagnet at an analysis angle of 30°. The measurements were made for initial pressures of the ion source from 2 to 84 μHg. The results show that the percentage of H_3^+ increases strongly with the pressure in a range from several microns to almost 100 μ. (J.S.R.)

27661 APPROXIMATE ANALYTICAL SOLUTION OF THE MOVEMENT OF A CHARGE IN A HIGH-FREQUENCY ACCELERATOR. Canobbio, Ernesto (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. B, 262: 996-9(Apr. 13, 1966). (In French).

An essentially nonadiabatic approximation for the movement of a charge in a nonhomogeneous static magnetic field under the action of a circular polarization wave was described. (tr-auth)

27662 RESEARCH CENTERS IN EUROPE. No. 16. FRASCATI. EuroNuclear, 3: 189-96(Apr. 1966).

The National Laboratories of Frascati are described. The electron synchrotron is discussed, its design and characteristics given, and experiments performed using the synchrotron are described. The Adone project in which a 1.5 Bev electron-positron storage ring is being constructed is also considered, and its design given. The Laboratory for Ionized Gases is discussed. At this laboratory the research is mainly concerned with collisionless phenomena and micro-instabilities in plasma, the production of very clean, well defined plasma from solid deuterium, and the compression of magnetic fields for producing very dense plasmas. (J.F.P.)

27663 FOCUSING AND STABILITY ANALYSIS OF INTENSE ELECTRON BEAMS IN PERIODIC MAGNETIC FIELDS. Danovich, I. A. (Scientific-Research Inst. of Radiotechnical Problems, Kiev). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 9: 351-61(1966). (In Russian).

An analysis of periodic magnetic focusing of electron beams is carried out, taking into account the real distribution of the focusing fields. The effect of nonsinusoidality of the magnetic fields and of radial changes of the induction magnitude on the focusing and stability of electron beams is studied. Relations are derived, permitting the parameters of the system providing the optimum regimes of beam focusing to be determined. These relations may also be used for calculating trajectories in short magnetic lenses and in transient regions of focusing devices. (auth)

27664 METHODS FOR DEVELOPMENT OF CYCLOTRON ACCELERATING SYSTEMS. Kannowade, H. (AEG, Forschungsinstitut, Frankfurt am Main). Nucl. Instrum. Methods, 41: 208-12(1966). (In German).

Calculation and experimental methods are described, with which cyclotron accelerating systems can be developed with a relatively low expenditure of time and materials. The calculation method is explained by reference to the 3-sector-accelerating system, as used in the relativistic isochron cyclotron in the research center at Karlsruhe. The extent to which this system can be used for other accelerating systems has to be decided on the merits of each individual case. The experimental method is based on the measurements conducted on a model of reduced dimensions by comparison with the original. It is generally applicable to resonators of any form. (auth)

27665 SOURCE OF POLARIZED IONS FOR A TANDEM ACCELERATOR. Gruebler, W.; Schwandt, P.; Yule, T. J.; Haeberli, W. (Univ. of Wisconsin, Madison). Nucl. Instrum. Methods, 41: 245-54(1966). (COO-7-0369).

A source of polarized negative hydrogen ions for a tandem accelerator is described. It consists of a conventional source of polarized protons or deuterons producing a beam of 0.15 μA. Negative ions are formed by charge exchange in a thin carbon foil. Under suitable conditions the beam can be accelerated without depolarization. The polarization of the proton beam after acceleration is 47%. The beam intensity passing through a 0.3 cm diameter aperture into a target chamber is 10^8 particles per second. (auth)

27666 SUPPRESSION OF MULTIPACTING IN PARTICLE ACCELERATORS. Hatch, A. J. (Argonne National Lab., Ill.). Nucl. Instrum. Methods, 41: 261-71(1966).

A new method of suppressing the multipacting breakdown between conductors in evacuated high-frequency systems such as in cyclotrons and linacs is described. Thin metallic or insulating baffles are used to subdivide the interconductor space into gaps narrower than that for multipacting cutoff. Measurements in a system with plane-parallel electrodes show the method to be effective and electrically nonperturbing. The experimental results are correlated with an "average electron" theory of multipacting developed previously and presented here in a form suitable for use by the accelerator designer. (auth)

27667 TWO GRAPHICAL CONSTRUCTIONS FOR BEAM TRANSPORT PROBLEMS. Randle, T. C. (Rutherford High Energy Lab., Chilton, Eng.). Nucl. Instrum. Methods, 41: 319-24(1966).

The two constructions enable the focusing effects of quadrupoles to be demonstrated. In the first, both the horizontal and vertical motion of a single particle are displayed simultaneously; in the second, a beam with elliptical area in phase space is followed in one plane only. The constructions give useful indications of where quadrupoles should be placed to produce desired beam properties. (auth)

27668 METHOD FOR INTEGRATION OF PARTICLE TRAJECTORIES IN AN EXPERIMENTALLY DETERMINED MAGNETIC FIELD. Olsen, B.; Petterson, G.; Schneider, W. (Uppsala Univ.). Nucl. Instrum. Methods, 41: 325-30(1966).

For the calculation of electron trajectories in experimentally measured long magnetic lens fields, the commonly used methods which utilize the vector potential were investigated and found not too successful. These methods are based on the principle of making a fit (e.g. least square fit) of the field on the axis. This gives a rather bad estimate of the field derivatives which enter the power expansion of the magnetic field in space appearing in the equations of motion. The method presented avoids this difficulty

by using field values in mesh points in a meridian plane. These can be obtained by solving the partial differential equations of the magnetic field. This requires a measurement of the field along a closed boundary instead of exclusively along the axis. An alternative way is to measure the B_r- and B_z-components directly in a grid. Thus only the r- and z-components of the field appear in the equations of motion and no derivatives are involved. The application of this method is not restricted to axial symmetric fields. It is e.g., very suitable for cyclotron fields. (auth)

27669 FOCUSING PROPERTIES OF LONG MAGNETIC LENSES. [PART] III. Lindgren, I.; Olsen, B.; Petterson, G.; Schneider, W. (Uppsala Univ.). Nucl. Instrum. Methods, 41: 331-7(1966).

A method for quantitative investigation of the focusing properties of long magnetic lenses is described. The basic principle is that a specific beta-ray spectrometer is simulated on a fast computer. A large number of trajectories are calculated with randomly distributed emission points and emission angles within given ranges. The number of trajectories which pass the baffle system gives directly the effective transmission. Several positions of the baffle system can be treated simultaneously. By running the simulation process for different momenta of the electrons the true resolution curve is obtained. An approximate resolution curve can be obtained from the simulation for one momentum value, if the dispersion is assumed to be constant. The method is applied to two fields of the intermediate-image type with very small spherical aberration and to one field of the triangular type with small source image. The results of the simulation process are compared with those of the more approximate method used previously, where the two focusing errors, spherical aberration and source image, are calculated separately and added together. The agreement is found to be satisfactory in all cases. The comparison also gives a relation between the base width and the half-width of the resolution curve, which can be utilized when the simpler method is used in other cases. (auth)

27670 KLYSTRON BUNCHING OF THE ION BEAM OF A 5.5 MV VAN DE GRAAFF. Anderson, J. H.; Batchelor, R.; Howe, F. A.; James, G.; Towle, J. H. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Nucl. Instrum. Methods, 41: 30-40(Apr. 1966).

Modifications to the AWRE 5.5 Mev Van de Graaff to improve its performance as a pulsed machine are described. A klystron bunching facility has been incorporated into the top terminal of the machine and pulsed ion beams with the pulse width about 1.5 ns and analyzed mean currents of 10 μA are obtained at 5 Mc/s repetition rate. (auth)

27671 FLUORESCENT SCREENS FOR ACCELERATORS. Cohen, D.; Roman, R. (Argonne National Lab., Ill.). Nucl. Instrum. Methods, 41: 149-50(Apr. 1966).

Details of the fluorescent screens developed at the Argonne ZGS for beam diagnostics are presented. The completed system consists of various phosphor-coated flags and transparent screens which could be remotely inserted into the beam path at a number of stations along the acceleration complex. The flags and screens were viewed by vidicon television cameras. The coating technique of these fluorescent screens is discussed. (B.G.D.)

27672 COMPENSATED IRON CHANNEL WITH HIGH SCREENING FACTOR FOR BEAM EXTRACTION FROM CYCLOTRONS. Mueller, R. W. (AEG-Forschungsinstitut, Frankfurt am Main); Berkes, B. Nucl. Instrum. Methods, 41: 151-2(Apr. 1966).

A new approach to the problem of electromagnetic compensation of iron channels to counteract the influence of the stray field of the iron parts on the orbits of the circulating beam in cyclotrons is presented in order to get a channel of small dimensions and a high screening factor. (B.G.D.)

27673 FAST CALIBRATION METHOD FOR CYCLOTRONS EMPLOYING INCREMENTAL TARGET POTENTIAL TECHNIQUES. Blyth, C. O.; Chesterfield, C. M.; Morris, J. M. (Univ. of Melbourne). Nucl. Instrum. Methods, 41: 164-6(Apr. 1966).

A fast calibration technique for cyclotrons is described, using a combination of incremental target potentials (0 to ±100 kv) and counting of induced activity, which enables measurement of the excitation functions involving small energy increments routinely with reasonable ease and rapidity. This method of operation negates the changing of machine energy and consequent refocusing or steering and results in increased beam stability and accuracy of measurements. (B.G.D.)

27674 POLARIZED NEGATIVE DEUTERIUM ION BEAM OBTAINED BY DEUTERIUM ATOMS IN THE 2S METASTABLE STATE. Cesati, A.; Cristofori, F.; Colli, L. Milazzo (Laboratori CISE, Milan). Phys. Lett., 21: 331-2(May 15, 1966).

A new polarized ion source for negative hydrogen or deuterium ions is described. The method is based on the properties of the 2S metastable state of one electron atom. The polarization is measured for deuterons with the $T(d,n)^4He$ reaction. (auth)

27675 MAGNETRON FREQUENCY STABILIZATION SYSTEM. Andreev, V. N.; Armenskii, E. V.; Rybin, V. M. (Moscow Engineering Physics Inst.). Prib. Tekh. Eksp., No. 6, 200-1(Nov.-Dec. 1965). (In Russian).

A system for stabilizing the frequency of a magnetron utilized as an h-f power oscillator in linear electron accelerators (3–10 Mev) is described. The basic element of the system is a discriminator in the form of a standard cavity resonator whose resonant frequency is periodically retuned. At an operating frequency of 3 Gc, frequency stabilization with an accuracy of 0.15–0.2 Mc is possible. Experiments have demonstrated the relative accuracy of the stabilization system to be 5×10^{-5}. The system can also be used for the automatic retuning of magnetron frequency in the 5–8-Mc range by shifting the adjusting rod of the resonator. (ATD)

27676 POLARIZED ELECTRON SOURCE FOR HIGH ENERGY ACCELERATORS. Hughes, V. W.; Long, R. L. Jr.; Posner, M.; Raith, W. (Yale Univ., New Haven, Conn.). pp 440-4 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

Polarized electrons were produced by the photoionization of a K atomic beam, and their polarization was measured using a Mott scattering apparatus. The method used to obtain polarized electrons from the photoionization of alkali atomic beams and the use of this technique in high-energy physics are discussed. (G.O.Y.)

27677 SURFACE IONIZATION SOURCE OF CESIUM IONS. Kuskevics, G.; Thompson, B. (Electro-Optical Systems, Inc., Pasadena, Calif.). Rev. Sci. Instrum., 37: 710-12(June 1966).

A surface ionization source using spherical-powder porous tungsten generates up to 9 mamp of cesium ions with only a few percent of neutral atoms. (auth)

27678 COMPUTER DESIGNED 805 MHz PROTON LINAC CAVITIES. Hoyt, Harry C.; Simmonds, Dennis D.; Rich, Walter F. (Los Alamos Scientific Lab., N. Mex.). Rev. Sci. Instrum., 37: 755-62(June 1966). (LA-DC-7697).

A numerical mesh calculation which computes the fields and frequency for a resonant cavity was developed. Fields for any cavity which has cylindrical symmetry and for which the magnetic field has only a θ component can be computed. The program was used on the IBM 7094 to study 805 Mc proton linac cavities. These design studies showed that cavities having curved walls and triangular drift tubes give improved performance. Calculated values of shunt impedance per unit length ZT^2 for such cavities range from 32.4 MΩ/m at $\beta = v/c = 0.45$ to 53.0 MΩ/m at $\beta = 1$. Experimental measurements verified the calculations. (auth)

27679 BOUND RESONANCE ($Q_R - Q_z = 1$) AND FRACTIONAL RESONANCE ($Q_z = 1/3$) IN ISOCHRONOUS CYCLO-

TRONS. Fang, Shou-hsien; Chang, Wen-ting; Wai, K'ai-yii. Sci. Sinica (Peking), 15: 318-28(Mar. 1966). (In Russian).

The preliminary investigation of the bound and fractional resonances in isochronous cyclotrons with induced disturbance of the primary harmonics of the radial components of the magnetic field was reported. The parameters on the 700-Mev JINR accelerator which is under reconstruction, were taken as examples. The results showed that this resonance phenomenon is rather strong. When the interference field attains 10 oersted, after completion of 10 to 30 revolutions, the amplitude of the particle oscillations in the vertical direction increased from 0.5 to 2 to 3 cm. The results of the investigation showed that during the theoretical design of accelerators of this type it is necessary to take this factor into account and to take appropriate engineering steps in order to avoid a large loss of the particle beam. (tr-auth)

27680 STORAGE RINGS WILL PERMIT COLLISIONS OF VERY HIGH-ENERGY PARTICLES. Goujon, Jean; Sittel, Robert. Sci. Progr.-Nature, No. 3371, 97-103(Mar. 1966). (In French).

The development of storage rings is briefly described. The Stanford electron storage ring and its principle of operation are considered. The Frascati electron-positron storage ring is also discussed. The Soviet construction of a storage ring with particles of the same sign but of opposing direction is described. The CERN proton storage ring is discussed briefly. (J.S.R.)

27681 HIGH ENERGY BEAM OPTICS. Steffen, K. G. New York, John Wiley and Sons, Inc., 1965. 211p. $9.50.

Comprehensive survey of the basic concepts of high-energy beam optics and study of the tools and methods employed for practical beam and spectrometer design work. It includes such topics as nonlinear aberrations, nondispersive and isochronous deflecting systems, sloped-window spectrometers, beam envelope formalism, the fast analog computer method, and acceptance of momentum and mass separators. There are many figures and graphs, and much new or hitherto sparsely published material. In a clear formulation, all relations are thoroughly derived and illustrated, where necessary, by simple numerical examples. Commencing with a simple derivation of the trajectory equations in a general magnetic field, trajectory optics in systems composed of quadrupole magnets are then presented. Other chapters include: the optics of deflecting magnets in a curved coordinate system; an investigation of some general properties of beam transport systems and spectrometers composed of quadrupoles and deflecting magnets; and starting from Liouville's theorem, an analysis of the phase space acceptance of beam transport magnets and composite magnet systems. (Int. Aerospace Abstr.)

27682 DINAMIKA CHASTITS V LINEINYKH REZONANSNYKH USKORITELYAKH. (Particle Dynamics in Resonance Linear Accelerators). Kapchinskii, I. M. Moscow, Atomizdat, 1966. 312p.

Longitudinal and transverse oscillations of particles in beams with negligibly small and with high space-charge density are examined, considering synchronization, particle phase stability, defocusing factors, strong focusing, coherent oscillations, effects of magnetic fields and of space charge, limiting beam current, and effects of the beam on the accelerating field. Methods for calculating beam focusing and intensity are given. (M.J.T.)

27683 MONTE CARLO CALCULATIONS OF PHENOMENA IN HIGH-ENERGY PROTON INTERACTIONS WITH TARGETS OR SHIELDING MATERIALS. Ranft, J. Leipzig, Univ., 1965. 84p. $2.00 Gmelin, AED-Diss. 65-271.

The efficiency of secondary particle production by interaction of the internal proton beam with targets in the vacuum chamber of an A. G. proton synchrotron is calculated with Monte Carlo methods. Results are in satisfactory agreement with experimental data. Nucleon-meson cascades in steel as shielding material are investigated. Results are extended to other shielding materials. (Gmelin Inst.)

27684 ROTATING DEVICE FOR BETATRONS OR SIMILAR HEAVY RADIATION SOURCES. Baldauf, Ludwig; Matthes, Ludwig; Kaschadt, Kurt (to Maschinenfabrik Augsburg-Nuernberg AG). German Patent 1,208,835. Jan. 13, 1966. Filed Feb. 13, 1964.

The betatron is in a radially adjustable manner attached to a rotable circular body which is supported by a curved roller path and the rotation axis so that a three-point bearing is obtained, and is provided with a counter-weight balance mounted also on the rotable circular body. The supply cables are wound around a drum which is attached to the rotable body on the opposite side of the betatron. (Gmelin Inst.)

Astrophysics and Cosmology

Refer also to abstracts 26788, 28133, 28137, 28138, 28539, and 28623.

27685 RECENT RESULTS IN COSMOLOGY. Sciama, D. W. (Univ. of Cambridge, Eng.). Advance. Sci., 22: 593-9(Feb. 1966).

The distribution and state of matter in the universe is discussed in terms of some concepts that were developed on the basis of radioastronomical and satellite observations. The physical state of the intergalactic gas is considered in detail. The strength of the intergalactic magnetic field is also discussed. (D.C.W.)

27686 DYNAMICAL INSTABILITY OF WHITE DWARFS IN THE GENERAL RELATIVITY FRAMEWORK. Baglin, Annie (Institut d'Astrophysique, Paris). Ann. Astrophys., 29: 103-7(Mar.-Apr. 1966).

It is shown that in the white dwarfs stage the relativistic effects can affect the stability. Models are unstable for smaller densities than those given by the classical criterion of stability. Different chemical compositions and central temperature are studied. (auth)

27687 ISOCHRONOUS CYCLOTRON OF THE FACULTE DES SCIENCES OF GRENOBLE. Jean, R.; Aucouturier, J.; Leboutet, H. (CSF-Compagnie Generale de Telegraphie Sans Fil, Orsay, France). Ann. Radioelec., 21: 122-50 (Apr. 1966). (In French).

An isochronous cyclotron for acceleration of protons up to 60 Mev and heavier particles was designed for the Faculte des Sciences of Grenoble. Unique features of this accelerator include a four spiralled sectors magnet with two r-f cavities and accelerating electrodes. The r-f cavities are of a new design avoiding sliding contacts and allowing tuning in operating conditions. Moreover this cyclotron was designed for axial injection of polarized particles, it offers thus wide possibilities for research in nuclear physics and chemistry. (auth)

27688 DEPLETION OF DEUTERIUM AND BERYLLIUM DURING PRE-MAIN-SEQUENCE EVOLUTION. Bodenheimer, Peter (Univ. of California, Berkeley). Astrophys. J., 144: 103-7(Apr. 1966).

Pre-main-sequence and early main-sequence evolutionary tracks are presented for masses which are of interest in connection with the depletion of the rare light nuclei deuterium and beryllium. Calculations show that deuterium in the surface layers is depleted through convective mixing during pre-main-sequence evolution in stars below about 3 $M_\odot$, while surface beryllium is depleted only in stars of about 0.6 $M_\odot$ or less. The results are discussed in terms of recent observations of the two species. (auth)

27689 STABILITY OF SUPERMASSIVE STARS. Fowler, William A. (California Inst. of Tech, Pasadena). Astrophys. J., 144: 180-200(Apr. 1966).

A study is presented which constitutes an extension of previous work on relaxation oscillations in supermassive stars. It is shown that a relatively small amount of rotation is sufficient to remove the general-relativistic instability which arises in such stars when rotation is absent. The post-Newtonian equations for the binding energy and

for the frequency of the fundamental mode of radial oscillation are derived and the close connection between these two quantities is exhibited. The equatorial instability associated with contraction under rotation is investigated and the results used to estimate the limiting mass in which hydrogen burning can be effective as a source of energy during relaxation oscillations. This limit is found to be at least 10^8 M ⊙ and perhaps as high as 10^9 M ⊙ whereas, without rotation, the limit arising from general relativistic considerations is 10^6 M ⊙. (auth)

27690 CENTRAL HOLE IN NGC 2237-2246. Mathews, William G. (California Inst. of Tech., Pasadena. Carnegie Inst. of Washington, D. C.). Astrophys. J., 144: 206-15(Apr. 1966).

The central cavity in the Rosette Nebula is regarded as the result of condensation into stars and/or as evidence of a high-temperature stellar wind. Other explanations seem less likely. (auth)

27691 INTEGRAL EQUATION FOR THE DEVELOPMENT OF IRREGULARITIES IN AN EXPANDING UNIVERSE. Gilbert, Ira H. (Brandeis Univ., Waltham, Mass. Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. J., 144: 233-40(Apr. 1966).

A calculation of the growth of irregularities in a statistically homogeneous and isotropic, dust-filled universe is presented in the Newtonian approximation. The description employed is based upon particle distribution functions rather than the hydrodynamic approximation. An integral equation for the spectrum of small-amplitude fluctuations is derived and numerically solved for the case of a Boltzmann single-particle velocity distribution function. It is found that the density contrast of large wavelength disturbances grows monotonically with time, but the density contrast of small wavelength disturbances first decays and later grows. The dividing line between these two types of behavior is at an initial wavelength of $\lambda = [\pi\langle\bar{v}^2\rangle/3\rho_0(t_0)G]^{1/2}$, where $\langle\bar{v}^2\rangle$ is the mean square peculiar velocity and $\rho_0(t_0)$ is the average density at t_0, the time at which the initial conditions are imposed. This value is related to λ_c, the Jeans critical wavelength at t_0 by, $\lambda = \lambda_c\gamma^{-1/2}$, where γ is the ratio of specific heats. (auth)

27692 OBSERVATIONS OF TYPE III AND TYPE IV SOLAR RADIO BURSTS AT 26.3 Mc/s. Malitson, Harriet H. (Goddard Space Flight Center, Greenbelt, Md.); Erickson, William C. Astrophys. J., 144: 337-51(Apr. 1966).

A source of type III bursts in the solar corona was observed at 26.3 Mc/s (11.4 meters) with the Clark Lake antenna during the period July 31–August 12, 1963. The height of the source was found to be 2.4 ± 0.2 $R_\odot$ from the center of the sun which presumably is the height of the plasma level for 26.3 Mc/s, corresponding to an electron density of 8.5×10^6 cm^{-3}. This height refers to the density in a coronal streamer over an active region and, together with determinations at frequencies of 1.5–201 Mc/s, corresponds to the density distribution with height of the van de Hulst model of the equatorial maximum corona, with all the densities multiplied by a factor of 10. No evidence was found for refraction in the corona. A moving type IV burst arising from a west-limb flare in the same active region on August 11 was observed to travel out through the corona at an angle of 32° north of the radial direction to about 6.3 $R_\odot$ from the center of the disk with a velocity of about 1400 km/s. After reaching this height, the source moved inward with a velocity of 380 km/s to an altitude of 5.4 $R_\odot$, where it remained until the end of the burst. The brightness distribution found for the source agrees with the core and halo model of Weiss and Sheridan for various types of bursts and the results of Erickson for type III bursts. The observed properties of the burst are in reasonably good agreement with those found by other workers for moving type IV bursts at frequencies of 40–169 Mc/s. (auth)

27693 OBSERVABILITY OF TAU A AS A NEUTRINO SOURCE. Castagnoli, Carlo; De Marco, Angelo; Pennego, Piero (Univ., Turin). Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur., 39: 72-6(July-Aug. 1965). (In Italian).

Tau A is examined as a possible neutrino source for subterranean observations of cosmic radiation. The neutrino spectrum of Tau A is examined and the signal and background are calculated. (J.S.R.)

27694 POLARIZATION OF HERRING-BONE FEATURES IN SOLAR RADIO BURSTS OF SPECTRAL TYPE II. Stewart, R. T. (Commonwealth Scientific and Industrial Research Organization, Chippendale, New South Wales). Austral. J. Phys., 19: 209-13(Apr. 1966).

The degree and phase of polarization of short-lived features in solar radio emission of spectral type II is investigated. It is found that although the type-II burst is in general weakly or negligibly polarized it may contain highly polarized elements. In particular, the fast-frequency drifting features that appear to diverge from a type-II burst ("herring-bone" features) are at times found to exhibit strong circular polarization. (auth)

27695 GAMMA PHOTONS OF 1.28 Mev EMITTED BY THE SUN AFTER A CHROMOSPHERIC ERUPTION. Barouch, Eleazar (Laboratoire de Physique Cosmique, Verrieres-le-Buisson, France). Compt. Rend., Ser. B, 262: 849-51(Mar. 21, 1966). (In French).

The flux of γ photons coming from the decay of ^{22}Na in the sun is calculated by taking into consideration the creation of these nuclei by the high-energy proton flux associated with a chromospheric eruption. (tr-auth)

27696 STUDY OF THE MICROSTRUCTURE OF THE ORGUEIL CARBONACEOUS METEORITE. Orcel, Jean; Alpern, Boris (Museum National d'Histoire Naturelle, Paris. CERCHAR, Creil, France). Compt. Rend. Ser. D, 262: 1393-7(Mar. 28, 1966). (In French).

Microscopic techniques for the petrography of carbons and electronic microprobe analysis were applied to polished sections of the Orgueil carbonaceous meteorite. The difficulties due to terrestrial contaminations were thus avoided and various mineral constituents were determined. However, the observations obtained gave no proof of the existence of fossil microorganisms in this meteorite. (tr-auth)

27697 MOTION OF PLASMA CLOTS DURING SURGES. Merkulenko, V. E. (Inst. of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, Academy of Sciences, USSR). Geomagn. Aeronomy (USSR)(Engl. Transl.), 5: 707-10(1965).

Translated from Geomagn. Aeronomiya, 5: 907-9(1965).

Solar surges which have the form of bands or bundles of luminous gas ejected from active regions in a zone with a strong magnetic field are studied. The pressure distribution on the surface of a clot responsible for this configuration is found for the case of clot motion at subsonic speed. (J.F.P.)

27698 DURATION OF SOLAR COSMIC-RAY EMISSION FROM THE REGION OF GENERATION. Dorman, L. I.; Miroshnichenko, L. I. (Inst. of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, Academy of Sciences, USSR). Geomagn. Aeronomy (USSR)(Engl. Transl.), 5: 710-12(1965).

Translated from Geomagn. Aeronomiya, 5: 910-12(1965).

The diffusion model is used to find results which permit the determination of the duration of cosmic ray emission from the solar region of generation from the time variation of solar cosmic-ray intensity. These results also show that the detailed measurements of the particle flux in the vicinity of the maximum of the increase are very important in the study of this duration. (J.F.P.)

27699 TEMPERATURE MODELS FOR THE OUTER SOLAR ATMOSPHERE. White, Marvin L. (Air Force Cambridge Research Labs., Bedford, Mass.); Kim, Koo Sun. Icarus, 5: 124-9(Mar. 1966).

A re-examination of "observed" electron densities in the solar corona and corona extended, plus Explorer X data shows that an inverse square law for the density variation is a good approximation. Such a law implies a constantly expanding model for the solar corona. An ana-

lytical expression is obtained for the temperature profile using this model. Without adjusting any constants, one obtains a temperature of 3500°K at 0.00025 solar radii above the limb, a maximum temperature of 1.65×10^6°K at 0.7 solar radii and 2.16×10^4°K at the earth's orbital distance. This temperature distribution is compared with one based on modifications of the hydrostatic model of Pottasch; a close agreement is found. The consequences of this agreement are discussed. (auth)

27700 POSITION OF JUPITER'S VAN ALLEN BELT. Roberts, J. A.; Ekers, R. D. (CSIRO, Sydney). Icarus, 5: 149-53(Mar. 1966).

A series of measurements is reported of the location of the centroid of the 11.3-cm Jovian radio emission relative to a nearby radio source whose position is known from a lunar occulation. The mean position of the centroid of the Jovian emission is close to the center of the planet, and any periodic movement as the planet rotates is much less than reported by Berge and Morris. (auth)

27701 COHERENT PLASMA RADIO EMISSION OF QUASARS AND REMNANTS OF SUPERNOVA STARS. Ginzburg, V. L.; Ozernoĭ, L. M. (Lebedev Inst. of Physics, Moscow). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 9: 221-33(1966). (In Russian).

The possibility is examined of interpreting the radio emission of the compact long-wavelength radio source in the Crab nebula and a portion of the radio emission of quasars by the coherent plasma mechanism. For the compact source in the Crab nebula this assumption is entirely sensible even without taking into account the effect of the magnetic field. In the case of quasars, the centimeter and decimeter variable radio emission may have a coherent plasma nature, apparently, only with allowance for the magnetic field. The problem of reabsorption of noncoherent synchrotron radiation in radio sources with homogeneous and nonhomogeneous magnetic fields is analyzed. (auth)

27702 SOLAR CYCLE AND ANNUAL VARIATIONS OF Sq(H) AT ALIBAG. Yacob, A.; Rao, D. Radhakrishna (Colaba Observatory, Bombay). J. Atmos. Terrest. Phys., 28: 351-60(Apr. 1966).

A study of the amplitudes and phase angles of the first two harmonics of the monthly Sq(H) at Alibag with respect to solar activity (sunspot number, R), for the period 1905-1960, shows that the amplitudes of both the harmonics have high positive correlations with R, the phase angle of the first harmonic is negatively correlated with R, but with rather low correlation coefficients, and that the phase angle of the second harmonic is uncorrelated with R. These findings confirm the earlier results obtained with annual mean values. Monthly linear regression equations are given for R and the amplitudes and phase angles. Annual variations of the amplitudes and phase angles, as well as those of the coefficients in the monthly linear regression equations, are shown for the entire period of the investigation and also for the solar maximum and minimum epochs. The annual variations of the phase angles show large changes for the latter half of the year with a sharp minimum in September and a maximum in November. These changes are similar for both the harmonics and the magnitudes as well as the character are the same for the solar maximum and minimum epochs, suggesting atmospheric tidal origin for the phenomenon. (auth)

27703 X RADIATION OF THE QUIET SUN. Mandel'shtam, S. L.; Prokudina, V. S.; Tindo, I. P.; Fetisov, E. P. Kosm. Issled., 3: 737-50(Sept.-Oct. 1965). (In Russian).

The results of computations of the thermal x radiation of the sun in the wavelength region shorter than 20 Å are examined, and the computed values of radiation fluxes compared with experimental data. To obtain a volumetric measure of the emission of the various regions of the corona that enter into the computational data, experimental values based on radiospectroheliograms at a wavelength of 9.1 cm are used. The temperature of the undisturbed corona is taken as $\sim 1 \times 10^6$°K, while for regions having an increased measure of emission temperature values of 1.5 to 2.5×10^6°K are assigned. Computational and experimental values of x-ray flux are in good agreement for different levels of solar activity, suggesting that the solar x radiation in the region $\lambda < 20$ Å is of a thermal nature. It is composed of the virtually constant component emitted from undisturbed coronal regions upon which the slowly changing component, corresponding to hotter radiation from active coronal regions, is superimposed. (tr-auth)

27704 ON THE SOLAR BURSTS OF SEPTEMBER 28, 1961 AND MARCH 20, 1958. Korchak, A. A. (Kosm. Issled., 3: 751-9(Sept.-Oct. 1965). (In Russian).

The burst of x rays accompanying the flares of Sept. 28, 1961, and March 20, 1958, is satisfactorily explained by bremsstrahlung of nonrelativistic electrons accelerated during the flares. The simultaneous generation of a radio burst can be explained by synchrotron radiation, if the electron energy spectrum is extended into the region of relativistic energies. The consequences of this hypothesis are examined. (tr-auth)

27705 MAGNETIC FIELDS IN STELLAR BODIES. II. MAGNETIC FIELDS IN UPPER MAIN SEQUENCE STARS. Monaghan, J. J. (Churchill Coll., Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc., 132: 1-14(1966).

Following the analysis given previously the structure of a weak, poloidal magnetic field inside a nonrotating, upper main sequence star was calculated for the case where the external field is dipole-like. The nonlinear equations involved were solved using a successive approximation technique which is rapidly convergent. The calculations show that the field structure is similar to that deduced for compressible polytropes in that the current associated with the field has an approximate radial variation proportional to the product of density and radius. It therefore has a sharp maximum deep inside the star. (auth)

27706 INFLUENCE OF STARK BROADENING ON ABUNDANCE DETERMINATIONS. Mugglestone, D.; O'Mara, B. J. (Univ. of Queensland, Brisbane). Mon. Notic. Roy. Astron. Soc., 132: 87-99(1966).

The contribution made by the Stark effect to line-broadening mechanisms in the solar atmosphere is considered. A program is developed whereby the Stark contribution may be computed and subsequently, through the consequent effect on the saturation function, the influence of the Stark effect on the determination of solar atmospheric abundances is obtained. In the case of sodium I the Stark influence on the derived abundance can be as large as a factor of 2 for individual lines considered; the average effect for all lines is found to be of the order of 40%. (auth)

27707 THE RADIO SOURCE CASSIOPEIA A. Minkowski, R. (Univ. of California, Berkeley). Nature, 209: 1339-40(Mar. 19, 1966).

Two models are considered for the interpretation of the nebulosity connected with the radio source Cassiopeia A. (B.G.D.)

27708 HELIUM PRODUCTION IN AN ANISOTROPIC BIG-BANG COSMOLOGY. Hawking, S. W.; Tayler, R. J. Nature, 209: 1278-9(Mar. 26, 1966).

The existence of an anisotropic universe as a modification to the hot big-bang theory in cosmology is discussed. It is shown that if such a phenomenon occurred, even for a few years, it could have a profound effect on helium production. (B.G.D.)

27709 WHY IS THE SKY DARK AT NIGHT? Layzer, David (Harvard Coll. Observatory, Cambridge, Mass.). Nature, 209: 1340-1(Mar. 26, 1966).

The intensity of the background radiation field is limited by distinct physical effects in three cosmologies considered. In a static universe it is limited (under present conditions) by the finite lifetime of the stars. In a steady-state universe the darkness of the sky is a direct consequence of the cosmic expansion. In an evolving universe, which is more complex, the stellar contribution to the background radiation field is limited in part by the finite lifetimes of stars and in part by the cosmic expansion. (B.G.D.)

27710 JUPITER'S RADIATION BELT. Barber, Derek (Royal Radar Establishment, Malvern, Eng.). New Sci., 29: 702-4(Mar. 17, 1966).

Continuous radio "noise" from Jupiter at wavelengths between 3 and 100 cm reveals that the planet has a substantial magnetic field and is surrounded by a rather dense belt of trapped energetic particles. The properties of this belt are described. (auth)

27711 IRREVERSIBILITY AND COSMOLOGY. Ludwig, G. pp 120-4 of Physikertagung 1965 Frankfurt (M)-Hoechst, Okt. 4-9. Vorabdrucke von Kurzfassungen der Fachberichte. Stuttgart, B. G. Teubner Verlagsgesellschaft mbH, 1965. (In German).

Step by step sharper properties for the dynamic behavior of microscopic bodies were discussed without mathematical proofs. It was accurately explained which dynamic properties lead to which microscopic behavior. The discussion is limited to idealized systems which are removed from their environment and are not affected by external disturbances. (tr-auth)

27712 MECHANISM OF SOLAR FLARES AND ASSOCIATED PHENOMENA. Sakurai, Kunitomo (Kyoto Univ.). Rep. Ionosphere Space Res. Jap., 19: 408-20(1965).

The stability of sunspot magnetic fields is considered theoretically in order to investigate the mechanism for solar flares. The interrelation of the solar-flare mechanism with the various kinds of particle emission and electromagnetic waves is examined in detail. The acceleration mechanism for solar cosmic rays and the emission mechanism for various solar radio outbursts are systematically considered. (J.F.P.)

27713 QUASI-STELLAR GALAXIES. McNally, D. (Univ. of London). Sci. Progr. (London), 54: 87-92 (Spring 1966).

The discovery of a new type of astronomical object, similar to the quasi-stellar radio sources, is described, and the role of these objects in cosmological theory and in theories of galaxy evolution is discussed. (auth)

27714 RADIOACTIVITY OF THE LUNAR SURFACE. Kraner, Hobart W. (Massachusetts Inst. of Tech., Cambridge); Schroeder, Gerald L.; Davidson, Gilbert; Carpenter, Jack W. Science, 152: 1235-6(May 27, 1966).

Diffusion of radon and thoron from the lunar surface provides a mechanism for production of a radioactive surface layer on the moon. If the radon and thoron flux from the lunar surface is equal to that measured at the earth's surface, the equilibrium activity of this surface layer is estimated as approximately 1 microcurie per square meter, due to radon and its decay products. This activity consists of alpha particles and gamma rays at well-defined energies and of beta rays. (auth)

27715 HEATING OF A PROMINENCE. Ioshpa, B. A. (Inst. of Terrestrial Magnetism, the Ionosphere, and Radiowave Propagation, Academy of Sciences, USSR). Soviet Astron. AJ (Engl. Transl.), 9: 583-4(Jan.-Feb. 1966).

Translated from Astron. Zh., 42: 754-6(July-Aug. 1965).

The character and rate of heating of a solar prominence by the surrounding corona is considered, taking into account the nonlinear dependence between the thermal conductivity coefficient and temperature. Radiative heat loss is not taken into account in the solution of the thermal conductivity equation. The heating rate in the absence of a magnetic field coincides with earlier estimates. (auth)

27716 CONCENTRATION AND IONIZATION OF MAGNESIUM IN THE SOLAR CHROMOSPHERE DETERMINED FROM EMISSION LINE OBSERVATIONS. Shilova, N. S. (Inst. of Terrestrial Magnetism, the Ionosphere, and Radio Wave Propagation, Academy of Sciences, USSR). Soviet Astron. AJ (Engl. Transl.), 9: 585-9(Jan.-Feb. 1966).

Translated from Astron. Zh., 42: 757-63(July-Aug. 1965).

Chromospheric MgI_{b_1,b_2,b_4} emission lines obtained using a coronagraph are analyzed. The equivalent widths are measured and self-absorption is taken into account. The quantity of MgI atoms in the chromosphere at a height of 1000 km is estimated. Ionization balance equations for the 3^1S and 3^3P^o levels are derived. The degree of MgI ionization and the hydrogen concentration at a height of 1000 km ($\log n_H = 13.6$) are found on the basis of these equations. Thermodynamic equilibrium is absent because the degree of ionization n_{MgII}/n_{MgI} is greater by a factor of 5 according to the Saha formula. (auth)

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Refer also to abstracts 28033, 28090, and 28456.

27717 (AD-631938) TABLE OF HARTREE-FOCK SELF CONSISTENT FIELD WAVE FUNCTIONS WITH EXCHANGE. Supplement I. Krueger, T. K.; McDavid, W. L.; Czyzak, S. J. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). Jan. 1966. 452p. (ARL-66-0014). CFSTI $7.52 cy, $2.00 mn.

A table is presented of the Hartree-Fock wave functions for various atoms and ions mainly of astrophysical interest having atomic numbers up to 28. Also included in the table are the one-electron energy parameters and the relativistic and spin-orbit energy corrections. (auth)

27718 (AD-632523) MACHINE COMPUTATION OF ESR SPECTRA. Harrah, L. A.; Waggoner, R. C.; Dunbar, D. J. (Air Force Materials Lab., Wright-Patterson AFB, Ohio). Feb. 1966. 60p. (AFML-TR-66-18). CFSTI $3.00 cy, $0.75 mn.

Three computer programs are given for the calculation of theoretical ESR spectra with M_i variations in line width, up to six independent coupling constants, and combinations of two distinct species. Spectra are reported for the case of two identical nuclei of spin $\frac{1}{2}$ and a second nonequivalent nucleus of spin $\frac{1}{2}$ with varying line widths and changing ratios of the two coupling constants. (auth)

27719 (IFA-FT-56) ELASTIC SCATTERING OF PHOTONS BY A HYDROGEN ATOM. Gavrila, M.; Constantinescu, D. H. (Institutul de Fizica Atomica, Academia R. P. R., Bucharest (Romania)). 1965. 26p. Dep. mn.

The Kramers-Heisenberg formula for elastic scattering of photons by atomic hydrogen in the dipole approximation is evaluated for all values of the photon energy. The method used is half analytical–half numerical and consists in approximating the integrands of some final integrals which result after transforming the matrix element, by functions which can be integrated in closed form. The calculations are tedious and yield an elementary though rather lengthy formula for the matrix element. This was also computed numerically. A discussion of the result and a comparison with previous results are given. (auth)

27720 (JINR-P-2636) SECHENIYA OBRAZOVANIYA ELEKTRON-POZITRONNYKH PAR V VODORODE, UGLERODE, FTORE, KHLORE, BROME I KSENONE γ-KVANTAMI S E_γ = 10-10000 Mev. (Cross Sections for Electron-Positron Pair Production by γ Quanta (E_γ = 10-10000 Mev) in Hydrogen, Carbon, Fluorine, Chlorine, Bromine and Xenon). Bem, Ya.; Grishin, V. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1966. 28p. Dep. mn.

Cross sections for electron-positron pair production by γ-quanta (E_γ = 10-10000 Mev) in hydrogen, carbon, fluorine, chlorine, bromine, and xenon were calculated. (auth)

27721 (NP-tr-1380) MULTI-PHOTON IONIZATION OF ATOMS AND MOLECULES IN A STRONG ELECTROMAGNETIC WAVE FIELD. Voronov, G. S.; Gorbunkov, V. M.; Delone, G. A.; Delone, N. B.; Keldysh, L. V.; Kudrevatova, O. V.; Rabinovich, M. S. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translated for Culham Lab., United Kingdom Atomic Energy Authority, Abingdon, Eng., from report A-115. 10p. (CTO-261). Dep. mn. CFSTI $1.00 cy, $0.50 mn; JCL $1.10 fs, $0.80 mf.

The results are reported of some first theoretical and experimental investigations of the multi-photon ionization of atoms and molecules. It is shown that the multi-photon

ionization and the tunnel effect are limiting cases of the ionization of an atom (molecule) in a strong variable electromagnetic field. A theory of this process is developed taking into account only an ionization mechanism in which the first virtual transition takes place from the bound state and all the following are virtual transitions between free states. The effect of the strong field on the upper electron levels in the atom, and the possibility of resonances during the absorption of photons are evaluated. An experiment is described in which the multi-photon ionization of a xenon atom (I = 12, 13 ev) and of a hydrogen molecule (I = 15, 43 ev) are observed in the electric field $E \sim 10^7$ v/cm of a ruby laser radiation ($\hbar\omega$ = 1.79 ev). The dependence of the probability of these processes on the field strength is measured. In both cases the ionization probability is determined by the probability of the absorption of a smaller number of quanta than the integer part of $\langle I/\hbar\omega + 1\rangle$. The absolute value of the probability of a multi-photon ionization of a xenon atom agrees satisfactorily with that calculated on the basis of the above theory. (auth)

27722 ELECTRON IMPACT CROSS SECTIONS FOR AERONOMY. Green, A. E. S. (Univ. of Florida, Gainesville). AIAA (Amer. Inst. Aeron. Astronaut.) J., 4: 769-75(May 1966).

A comparison of various systematic approaches to the problem of arriving at electron impact cross sections for atoms and molecules, which might have applications in aeronomy and space physics, is presented. An attempt is made to find features common to all. To do this in a quantitative manner, the use of a universal excitation cross-section function, which can be used to approximate any of the proposed systematic cross sections is explored. (B.G.D.)

27723 YIELD AND ANGULAR DISTRIBUTION OF CESIUM-SPUTTERED COPPER USING A RADIOACTIVE TRACER TECHNIQUE. Olson, N. Thomas; Smith, Harold P. Jr. (Univ. of California, Berkeley). AIAA (Amer. Inst. Aeron. Astronaut.) J., 4: 916-20(May 1966).

A radioactive tracer technique has been developed and applied successfully to the measurement of the yield and angular distribution of copper sputtered from a monocrystalline target under bombardment by a 1 to 10 kev cesium ion beam with the beam perpendicular to the (100) crystallographic face. The yield reaches a maximum of 7.8 at 7 kev and is considerably lower than that reported for polycrystalline targets. The relative openness of the (100) face is the probable reason for the significant reduction. Measurement of the absolute angular distribution shows that emission in the close packed ⟨110⟩ direction is insensitive to ion energy, whereas emission in the ⟨100⟩ direction increases as the ion energy is varied from 1 to 5 kev but is constant from 5 to 10 kev. Ejection along the ⟨110⟩ direction is skewed to greater polar angles than that associated with the close packed direction in copper. These effects are interpreted as suggesting that long, focused collision chains are not of primary influence in causing a sputtering event. (auth)

27724 SOURCE OF HIGH-ENERGY NEUTRAL PARTICLES. Warnecke, R. J.; Vincent, G.; Masic, R. (CSF-Compagnie Generale de Telegraphie Sans Fil, Orsay, France). Ann. Radioelec., 21: 71-91(Apr. 1966). (In French).

Following a description of the essential part of the theoretical and experimental work carried out in their laboratory under a D.R.M.E.-CSF contract for the study of exchange reactions of charges which appear when a beam of fast ions passes into a thin gas target, a description and the characteristics of a source of neutral H_1^0 particles of high intensity and energy are given. (auth)

27725 ENERGY LEVELS OF DOUBLE-WELL POTENTIALS. Froeman, Nanny. Ark. Fys., 32: 79-97(1966).

The quantal bound state problem when there are two classically allowed regions separated by a potential barrier is treated rigorously according to the general theory for higher order approximations of the JWKB-type. An exact quantization condition, applicable to energy levels below the barrier maximum as well as above it, is derived. From this exact formula the approximate quantization condition corresponding to any desired order of the approximations considered can be obtained. Upper bounds for the terms neglected in obtaining the approximate formulas are derived. (auth)

27726 OSCILLATOR STRENGTHS FOR SINGLET AND TRIPLET SERIES IN NEUTRAL HELIUM. Green, Louis C.; Johnson, Norma C.; Kolchin, Eleanor K. (Haverford Coll., Pa.). Astrophys. J., 144: 369-75(Apr. 1966). (TID-22149).

Oscillator strengths have been computed for all possible electric dipole transitions between the terms n^1S, n^3S, n^1P, n^1D, and n^3D, where n goes from one to nine for S terms, from two to eight for P terms, and from three to eight for D terms. The computations were carried through using central-field wave functions with exchange and configuration interaction. The parameters in these wave functions had previously been determined by the use of the minimum principle. The oscillator strengths as computed by the length and velocity expressions are reported. For the 1^1S-n^1P series, the results found with the acceleration expression are also included. The agreement between the results obtained with the length and the velocity expressions as well as that between the present work and earlier computations, where available, give confidence in the dependability of the results. (auth)

27727 NEW INNER-SHELL RESONANCE LINES IN HIGHLY IONIZED SULFUR AND CHLORINE. Deutschman, William A.; House, Lewis L. (High Altitude Observatory, Boulder, Colo.). Astrophys. J., 144: 435-7 (Apr. 1966).

A recently constructed light source capable of producing the spectra of highly ionized elements is described. The light source being a high-energy theta-pinch plasma machine. New energy-level data of importance in isoelectronic sequences of coronal-type ions are presented. (B.G.D.)

27728 ENERGY SPECTRA OF IONS EMITTED BY BERYLLIUM, CARBON, AND MOLYBDENUM UNDER THE EFFECTS OF A LASER BEAM. Tonon, Gianfranco (CEA, Villeneuve-Saint-Georges, France). Compt. Rend., Ser. B., 262: 706-9(Mar. 7, 1966). (In French).

The energy spectrum of various types of ions obtained during the action of a concentrated laser beam on beryllium, carbon, and molybdenum targets was traced. The effect of the laser intensity was also studied in the case of carbon. (tr-auth)

27729 ENERGY AND ANGULAR DISTRIBUTION OF SECONDARY IONS EMITTED BY ALUMINUM AND COPPER. Castaing, Raymond; Hennequin, Jean-Francois (Faculte des Sciences, Orsay, France). Compt. Rend., Ser. B, 262: 1008-11(Apr. 13, 1966). (In French).

The secondary ions emitted by Al and Cu under bombardment by 8-kev argon ions have energy and spatial distributions very different from those observed under similar conditions for neutral atoms emitted. The intervention of focused collision chains, predominant for the ejection of neutral atoms, does not appear evident in the ion emission. (tr-auth)

27730 NEW EMISSION BANDS OF Re, W, Ta, Te, Sb, Pd, Mo, Nb, AND Ti IN THE ULTRASOFT X RAY REGION OF THE SPECTRUM. Lukirskii, A. P.; Brytov, I. A.; Fomichev, V. A. (Univ., Leningrad). Fiz. Tverd. Tela, 8: No. 1, 95-102(Jan. 1966). (In Russian).

An x-ray spectrometer with diffraction grating was used to obtain previously unreported emission bands of several metals and semiconductors. The identification of these bands is suggested. Positions and width of the following bands are in ev: Re, O_{II}, 53 ± 0.7, 4.1 ± 0.2; O_{III}, 40.4 ± 0.4, 1.7 ± 0.2; W, O_{II}, 48.6 ± 0.6, 3.2 ± 0.2; O_{III}, 36.6 ± 0.3, 1.5 ± 0.2; Ta, O_{II}, 43.5 ± 0.8, -; O_{III}, 32.5 ± 0.2, 1.1 ± 0.2; Hf, O_{III}, 29.0 ± 0.2, -; Nb, $N_{II,III}$, 30.4 ± 0.2, 0.8 ± 0.2; Mo, $N_{II,III}$, 35.1 ± 0.3, 1.6 ± 0.2; Pd, N_{II}, 54.6 ± 0.9, -; N_{III}, 50.4 ± 0.8, -; Te, N_V, 38.6 ± 0.4, -;

Sb, N_{IV}, 33.0 ± 0.3, N_V, 30.2 ± 0.2. Traces for most elements are reproduced, showing the assignments of the new emission bands. (BBB)

27731 FIRST SPECTRUM OF PROTACTINIUM. Giacchetti, A. (Argonne National Lab., Ill.). J. Opt. Soc. Amer., 56: 653-7(May 1966).

The spectrum of protactinium was photographed between 2500 Å and 9200 Å. The wavelengths of 8617 lines were measured and the separation of the first and second spectra was accomplished for 80% of the lines. Zeeman effects were measured in the region between 4000 Å and 9000 Å. Thirty-two even levels and 252 odd levels were found; these are listed together with their electronic angular momenta J and g_j values as derived from the Zeeman effect. The ground configuration of the neutral atom of protactinium is $5f^26d7s^2$. (auth)

27732 WAVELENGTHS, INTENSITIES, AND ZEEMAN PATTERNS IN YTTERBIUM SPECTRA (Yb I, II, III, IV). Meggers, William F.; Corliss, Charles H. J. Res. Nat. Bur. Stand., 70A: 63-106(Jan.-Feb. 1966).

In 1937, Meggers and Scribner studied arc and spark spectra of ytterbium providing wavelengths, relative intensities, and spectrum numbers of 1668 spectral lines, including about 400 for Yb(I), 1250 for Yb(II), and 12 for Yb(III). This was handicapped by impure materials and conventional light sources. When pure ytterbium metal and new light sources became available in 1950, Meggers and Corliss made a new description of ytterbium spectra. This new description includes data for 7300 spectral lines with wavelengths between 2000 and 12,000 Å distributed as follows: 1800 belong to Yb(I), 5100 to Yb(II), 430 to Yb(III), and 5 to Yb(IV). The Zeeman effect on 1300 lines was observed in magnetic field intensities ranging from 3.7 to 9.358 tesla (37,000 to 93,580 gauss). These data were obtained for chemical identifications and for structural analyses of the first two spectra of ytterbium. (auth)

27733 FIELD DISSOCIATION PROBABILITIES OF H_2^+. Wind, H. (Culham Lab., Abingdon, Eng.). Nucl. Fusion, 6: 67-8(Mar. 1966).

For 31 highly excited states of H_2^+ a value of the dissociation probability as a function of the electric field is computed. The field range is from 5×10^3 to 1×10^5 v/cm. The accuracy, mainly governed by the neglect of the Stark shift, is 5 to 7 percent. There is good agreement with experimental observations. (auth)

27734 EXCITATION OF HYDROGEN BY PROTON IMPACT. Callaway, J.; Dugan, A. F. (Univ. of California, Riverside). Phys. Lett., 21: 295-7(May 15, 1966).

Numerical computations of the cross section for the excitation of hydrogen by proton impact were made. Exact matrix elements were used in a procedure based on the impact parameter method. Cross sections were in good agreement with those of Bell and Skinner and were too large in relation to experimental observations. (auth)

27735 MEASUREMENT OF THE ISOTOPE SHIFT IN ^{134}Cs. Huehnermann, H.; Wagner, H. (Univ., Marburg, Ger.). Phys. Lett., 21: 303-5(May 15, 1966). (In German).

Electromagnetically enriched ^{134}Cs produced by neutron activation was used to investigate the isotopic shift of the two resonance lines of ^{134}Cs versus ^{133}Cs. The B-factor of the splitting of the $6p\ ^2P_{\frac{1}{2}}$ ^{134}Cs term was measured. (auth)

27736 μ-ATOM ISOTOPIC SHIFT. Mikulinskii, M. A.; Osadchiev, V. M. (Kurchatov Inst. of Atomic Energy, USSR). Phys. Lett., 21: 312-13(May 15, 1966).

Using Migdal's theory of finite Fermi systems, the isotope shift is calculated for calcium and oxygen isotopes. An approximate connection with the electronic isotope shift is made. (auth)

27737 HYPERFINE SPLITTINGS AND g_F VALUES OF METASTABLE H_2. Chiu, Lue-Yung Chow (Catholic Univ. of America, Washington, D.C. Goddard Space Flight Center, Greenbelt, Md.). Phys. Rev., 145: 1-7(May 6, 1966).

The energy arising from the hyperfine interaction, the interaction with the magnetic field, and the cross term between them was studied for ortho-H_2 in the $c^3\pi_u$ state. The cross term gives rise to a first-order correction of the g_F values which accounts for the discrepancies between the theoretical zeroth-order g_F and the experimental values. The interactions are expressed as products of irreducible spherical tensors, and Racah's method is used to derive all the diagonal and off-diagonal matrix elements. The case of the rotational level N = 1 is presented in detail. The coupling constants of hyperfine structure were evaluated by using a single-configuration electronic wave function for the $c^3\pi_u$ state of H_2. (auth)

27738 X-RAY PRODUCTION IN THE L SHELL OF COPPER BY 25- TO 1700-ev PROTONS. Khan, J. M.; Potter, D. L.; Worley, R. D. (Univ. of California, Livermore). Phys. Rev., 145: 23-4(May 6, 1966). (UCRL-14526).

L-shell x rays of copper were produced by stopping 25- to 1700-kev protons in a thick target. X rays associated with the production of initial vacancies in the L_{III} shell were isolated by an absorption technique. Total L-shell x-ray yield is presented, as well as yield, production, and ionization cross sections for the L_{III} shell. The Born approximation is compared with the experimental ionization cross section and is found to be consistently high over the whole range of bombarding energies. (auth)

27739 ELECTRON CAPTURE FROM ATOMIC NITROGEN BY PROTONS. Mapleton, Robert A. (Air Force Cambridge Research Labs., Bedford, Mass.). Phys. Rev., 145: 25-6(May 6, 1966).

The total Oppenheimer–Brinkman–Kramers (OBK) cross sections for 1s-, 2s-, and 2p-orbital electron capture from atomic nitrogen by protons are adjusted to correspond to capture from N_2 by deuterons, and are compared with recent measurements of Berkner et al. Calculated cross sections for 1s capture are dominant above 3 Mev, and the total OBK cross section still exceeds the measured cross section at the deuteron energy of 21.5 Mev. (auth)

27740 CALCULATION OF AUTO-IONIZATION RATES. Manson, Steven Trent (Columbia Univ., New York). Phys. Rev., 145: 35-40(May 6, 1966).

A method was formulated to calculate auto-ionization rates by perturbation theory with no internal inconsistencies. Calculations were carried out in $(2s)^2\ ^1S$ He, $(2s,2p)\ ^{1,3}P$ He, $(1s,2s,2p)\ ^4P_{\frac{1}{2}}$ Li, and $(1s,2s,2p)\ ^2P_{\pm}$ Li. The applicability of this formulation, as well as how it differs from previous perturbation methods, is discussed. (auth)

27741 CESIUM IONIZATION CROSS SECTION FROM THRESHOLD TO 50 ev. Heil, H.; Scott, B. (Hughes Research Labs., Malibu, Calif.). Phys. Rev., 145: 279-84(May 6, 1966).

The Cs ionization cross section σ, which was recently measured by Brink at 50 ev and above, was measured down to threshold in a Tate- and Smith-type apparatus design for absolute measurements. The density in the collision space was determined by the surface ionization detector which permitted an over-all accuracy on the cross section of 10%. The results are: $\sigma = 5.3$ Å^2 at 50 ev. This is smaller by a factor of 1.8 than the results of the above experiment and the theoretical values of the Gryzinski method–the discrepancy has not been explained. The cross section near threshold is linear over a range of 0.8 ev with a slope of 2.2 Å ev^{-1}. Above 0.8 ev, it rises less than linearly. The initial slope is smaller by a factor of 3 than the earlier measurements of Nottingham. Above 12 ev, excitation to the auto-ionizing states is seen, and above 18 ev, an additional contribution to the total cross section begins. The latter is due to ionization to an excited state of the ion. Cross sections for these two processes were related to spectroscopic measurements of Beutler et al. and were separated from the basic ionizing channel. The curve for auto-ionization is resonant in nature with a maximum of 0.8 Å^2. The ionization to the excited ion has an estimated maximum cross section of 1.5 Å^2 at 60 ev. (auth)

27742 COLLISIONAL BREAKUP OF HIGH-ENERGY H_2^+ IONS. Berkner, Klaus H.; Kaplan, Selig N.; Pyle, Robert V.; Stearns, J. Warren (Univ. of California, Berkeley). Phys. Rev., 146: 9-16(June 3, 1966). (UCRL-11217).

The gas collisional cross sections for breakup of 20.9-Mev H_2^+ ions into $H^0 + H^+$ and $H^+ + H^+ + e$ were measured in H_2, He, N_2, and Ar. Total dissociation cross sections in the same gases and in the energy range 10 to 65 Mev were deduced from radial-attenuation measurements on the internal beam of the Berkeley 88-in. cyclotron. These cross sections were also calculated for each of the H_2^+ molecular-ion vibrational levels and for an average over the vibrational levels, with an approach proposed by Salpeter. The measured and calculated average cross sections are in good agreement. (auth)

27743 COINCIDENCE MEASUREMENTS OF LARGE-ANGLE Ar^+-ON-Ar COLLISIONS. Kessel, Quentin C.; Everhart, Edgar (Univ. of Connecticut, Storrs). Phys. Rev., 146: 16-27(June 3, 1966).

Large-angle single collisions of kev-energy Ar^+ ions with Ar atoms are studied wherein both particles scattered from the same encounter are detected in coincidence. The scattered incident particle appears m-times ionized at angle θ and the recoiling target particle appears n-times ionized at angle ϕ. Values of m and n range from zero to eight. It is found that m and n are independent and uncorrelated, i.e., the distribution among charge states m is the same regardless of the charge state n seen in coincidence. An exception to this rule is seen in one region where the inelastic energy has multiple values. Relative probabilities for the (m,n) reaction are given for many data sets, with incident energies T_0 from 3 to 400 kev and for angles θ between 8° and 40°. The inelastic energy $\overline{Q}_{mn}$ associated with the (m,n) reaction is also measured for a number of values of m and n in each data set. It is found that a particular reaction does not have a fixed characteristic energy. Thus, for example, $\overline{Q}_{55}$ increases from 877 to 1473 ev depending on the violence of the collision. Average values of inelastic energy loss $\overline{Q}$ are plotted versus incident energy at various scattering angles, versus the average number of electrons lost in the collision, and versus the distance of closest approach. Values of $\overline{Q}$ range from 26 ev at $T_0 = 3$ kev, $\theta = 8°$, to 2430 ev at $T_0 = 300$ kev, $\theta = 40°$. The effects of thermal motion of the target atom, of finite instrumental resolution, and of a possible distribution in values of inelastic energy all combine to give "linewidth" effects. These are measured and discussed. (auth)

27744 STATISTICAL MODEL FOR THE Ar^+-ON-Ar COLLISION. Everhart, Edgar; Kessel, Quentin C. (Univ. of Connecticut, Storrs). Phys. Rev., 146: 27-36(June 3, 1966).

A model is introduced to describe and predict experimental results on Ar^+-Ar scattering. In considering a number of collisions in a data set it is assumed that there is a distribution among the inelastic energies of the atoms after the collision. It is further assumed that the energy received by one atom is not correlated with the energy received by the other atom in the same collision. The model, whose distribution widths are fitted to the data, predicts the average inelastic energy loss $\overline{Q}_{mn}$ associated with a collision which results in one atom becoming m times ionized and the other n times ionized. The relative abundance $\overline{p}_{mn}$ of the (m,n) reaction is also predicted. The values of $\overline{Q}_{mn}$ and $\overline{p}_{mn}$ so predicted agree well with the data. The model allows derivation from the data of the probability P_i that an atom, which received a particular inelastic energy E, subsequently becomes i times ionized. These derived $P_i(E)$ curves are rather similar in form to those which have been calculated by Russek. Under some circumstances there is a triply peaked structure to the inelastic energies transferred in these collisions. This structure is explained within the framework of the present model. Indirect evidence is presented that in the more violent collisions there may be one fast electron emitted per atom whose kinetic energy is a sizable fraction of the inelastic energy. (auth)

27745 X-RAY SCATTERING FORM FACTORS WITH RELATIVISTIC WAVE FUNCTIONS. Chattarji, D. (Duke Univ., Durham, N. C.); Swamy, N. V. V. J. Phys. Rev., 146: 43-6(June 3, 1966).

Using the solutions of the Biedenharn symmetric hamiltonian, relativistic effects in x-ray scattering from xenon were estimated and the results compared with Hartree-Fock values and experimental measurements. (auth)

27746 ELECTRON CAPTURE INTO THE 3s STATE OF HYDROGEN BY FAST-PROTON IMPACT ON GASES. Hughes, R. H.; Dawson, H. R.; Doughty, B. M.; Kay, D. R.; Stigers, C. A. (Univ. of Arkansas, Fayetteville). Phys. Rev., 146: 53-60(June 3, 1966).

Absolute cross sections for electron capture into the 3s state of hydrogen by fast-proton (5–115 kev) impact were determined for impact on He, Ar, Ne, N_2, H_2, and O_2. The helium cross sections agree with Mapleton's Born-approximation calculations at about 115 kev. Curves of argon and neon cross sections versus proton energy show structure similar to that found in the 2s state by Jaecks et al., indicating that the influence of ground-state capture extends to the n = 3 level. The N_2 and O_2 cross sections are similar. The O_2 curve shows additional structure. At 100 kev the ratio of the 3s capture to the total capture is 0.03 to within 15% for all six gases. (auth)

27747 SHIELDING AND ANTISHIELDING EFFECTS FOR VARIOUS IONS AND ATOMIC SYSTEMS. Sternheimer, R. M. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 146: 140-60(June 3, 1966). (BNL-9935).

The results of calculations of several shielding and antishielding effects pertaining to the hyperfine structure of various ions and atomic systems are reported. The following shielding (or antishielding) parameters were considered in the present work: (1) the parameter σ_2 for the rare-earth ions, which measures the reduction of the $A_2 r^2 P_2(\cos\theta)$ term of the crystal field at the location of the 4f electrons due to the shielding effect of the more external 5s and 5p electrons; (2) the quadrupole antishielding factor γ_∞ which gives the total quadrupole moment induced in the closed shells of an ion by the nuclear quadrupole moment induced in the closed shells of an ion by the nuclear quadrupole moment Q; (3) the corresponding atomic shielding factor R which describes the effect of the induced quadrupole moment on the valence electrons; (4) the hexadecapole antishielding factor η_∞, which is analogous to γ_∞, except that it pertains to the induced hexadecapole (16-pole) moment produced by a possible nuclear electric hexadecapole moment. The calculated values of σ_2 for the Pr^{3+} and Tm^{3+} ions are in good agreement with the experimental results. Improved values of γ_∞ were obtained for the following ions: Al^{3+}, Cs^+, I^-, Pr^{3+}, and Tm^{3+}. The atomic shielding factor R was calculated for the 4f electrons of Pr^{3+} and Tm^{3+}, and was found to be in reasonable agreement with experiment. A discussion is given of the most likely regions of atomic number for which it might be possible to detect a nuclear hexadecapole moment. In addition, an evaluation of the second-order terms in the antishielding factor γ_∞ for the Cl^- ion has been carried out. Expressions for $\gamma_\infty(nl \to l \pm 2)$ for the case of hydrogenic wave functions were obtained. (auth)

27748 ENERGY LOSS OF FISSION FRAGMENTS IN LIGHT MATERIALS. Mulas, Pablo M.; Axtmann, Robert C. (Princeton Univ., N. J.). Phys. Rev., 146: 296-300 (June 3, 1966).

A calibrated silicon detector provided range-energy data for ^{252}Cf fission fragments in H_2, D_2, N_2 and Mylar. Bohr's classical stopping-power theory and Lindhard's more recent Thomas-Fermi model both underestimate the measured energy losses. For both theories, the discrepancy with experiment is a monotonic function of the atomic number of the stopping material, at least for the limited range of materials studied. (auth)

27749 FISSION-FRAGMENT SCATTERING. Engelkemeir, D. (Argonne National Lab., Ill.). Phys. Rev., 146: 304-9(June 3, 1966).

The scattering of fission fragments of ^{252}Cf from a thick, flat sheet of platinum was studied with a coincidence arrangement using silicon surface-barrier detectors. Data are presented showing the percentage of fragments scattered out of the platinum as a function of angle of entry of the fragments. At low (grazing) angles of entry 50% or more of the fragments entering the platinum are scattered out. The scattering decreases rapidly with increasing entrance angle and is less than 1% at 30°. (auth)

27750 OBSERVATION OF DOPPLER-SHIFTED PEAKS IN THE ENERGY SPECTRUM OF AUTOIONIZATION ELECTRONS FROM Ar^+-Ar COLLISIONS. Rudd, M. E.; Jorgensen, T. Jr.; Volz, D. J. (Univ. of Nebraska, Lincoln). Phys. Rev. Lett., 16: 929-30(May 23, 1966).

The observation of Doppler-shifted peaks in the electron energy spectrum from Ar^+-Ar collisions at 50 to 150 kev is discussed. In viewing the electrons ejected in a nearly backward direction (160°) relative to the beam of ions, it was found that a number of characteristic peaks which shift with beam energy and a number of others do not. Furthermore, there is a detailed correspondence between the shifted and unshifted sets. The latter sets come from the nearly stationary target atoms, while the shifted electrons are from the fast beam particles. (B.G.D.)

27751 IMPORTANCE OF RELATIVISTIC EFFECTS IN THE SCATTERING OF SLOW ELECTRONS. Rotenberg, Manuel (Univ. of California, San Diego, La Jolla). Phys. Rev. Lett., 16: 969-71(May 30, 1966).

An attempt is made to improve the model proposed by Bauer and Browne (Phys. Rev. Letters, 16: 495(1966)) on the relativistic effects of the scattering of slow electrons. (B.G.D.)

27752 PARTIAL IONIZATION CROSS SECTIONS OF NOBLE GASES FOR ELECTRONS WITH ENERGY 0.5-16 kev. I. HELIUM AND NEON. Schram, B. L.; Boerboom, A. J. H.; Kistemaker, J. (FOM Lab. voor Massascheiding, Amsterdam). Physica, 32: 185-96 (Jan. 1966).

Partial ionization cross sections were determined for the production of singly and doubly charged helium ions and of neon ions with charge up to 5+. Results were compared with the Bethe-Born approximation, which is satisfied at the higher energies. The experiments show that the multiply charged ions are produced by various mechanisms, namely by a direct multiple ionization, or by an innershell ionization followed by an Auger-process, occasionally combined with shake-off transitions. (auth)

27753 PARTIAL IONIZATION CROSS SECTIONS OF NOBLE GASES FOR ELECTRONS WITH ENERGY 0.5–18 kev. II. ARGON, KRYPTON AND XENON. Schram, B. L. (FOMLab. voor Massascheiding, Amsterdam). Physica, 32: 197-208(Jan. 1966).

Partial ionization cross sections of argon, krypton and xenon were determined for electrons with energy 0.5–18 kev. The following ions were observed: argon up to 7+, krypton up to 9+ and xenon up to 13+. The results were found to be in agreement with the Bethe-Born approximation. Our experiments show that the multiply charged ions are produced to a large extent via inner shell ionizations. (auth)

27754 RESONANCE ENERGY TRANSFER AND SPONTANEOUS PHOTON EMISSION. Avery, J. S. (Imperial Coll. of Science and Tech., London). Proc. Phys. Soc., 88: 1-8(May 1966).

The Perrin-Förster theory of sensitized fluorescence is extended by replacing the Coulomb interaction with its relativistic counterpart, the Breit interaction. The transition matrix element is evaluated in a multipole expansion. The matrix element is found to be modulated by the retardation factor e^{ikR} and to contain terms which fall off only as $1/R$. The relation of these terms to spontaneous photon emission and their application to exciton theory are discussed. (auth)

27755 FIRST-ORDER EXCHANGE APPROXIMATION: THE EXCITATION OF THE 2 ^3S AND 2 ^3P STATES OF HELIUM BY ELECTRON IMPACT. Bell, K. L.; Eissa, H.; Moiseiwitsch, B. L. (Queen's Univ., Belfast). Proc. Phys. Soc., 88: 57-63(May 1966).

Cross sections for the excitation of the 2 ^3S and 2 ^3P states of helium from the ground state by electron impact are calculated using the first-order exchange approximation. In the case of the excitation of the 2 ^3S state it is found that at low electron energies the cross section given by this approximation is about a factor of 10 smaller than that obtained by using the Born–Oppenheimer approximation, although it is still somewhat larger than the experimental data. For the case of the excitation of the 2 $^3P_0$ state, the reduction in the cross section brought about by employing the first-order exchange approximation rather than the Born–Oppenheimer approximation is less marked, while the two approximations are identical for the excitation of the 2 $^3P_{\pm 1}$ states. (auth)

27756 ELECTRON EXCITATION FROM THE GROUND STATE OF HELIUM TO THE 3 ^1D STATE. Fox, M. A. (Univ. of London). Proc. Phys. Soc., 88: 65-9(May 1966).

The sensitivity of the cross section to the ground-state wave function is investigated by considering the Born approximation to the scattering amplitude in the limit of zero momentum change. The total Born cross section is calculated using two alternative formulations and at an energy of 108 ev the results obtained are smaller than the value measured by Heddle and Gabriel in 1960 by a factor of at least 2. Further Born calculations indicate that coupling with 3 ^1P as an intermediate state is not important but calculations made by Somerville in 1963 suggest that coupling to 2 ^1P may be important. (auth)

27757 THE APPLICATION OF RUBINOW'S VARIATIONAL METHOD TO ZERO ENERGY SCATTERING OF ELECTRONS BY HYDROGEN ATOMS. John, T. L.; Williams, K. L. (Univ. Coll., Cardiff). Proc. Phys. Soc., 88: 71-4(May 1966).

The relation between the Rubinow and Hulthén second variational methods is shown. In applications to zero energy electron–hydrogen scattering the Rubinow method with one-parameter trial functions gives results as accurately as the Hulthén–Kohn methods with two-parameter trial functions. (auth)

27758 THE FIRST BORN APPROXIMATION FOR COLLISIONS BETWEEN HEAVY PARTICLES. Crothers, D. S. F.; Holt, A. R. (Queen's Univ., Belfast). Proc. Phys. Soc., 88: 75-81(May 1966).

Cross sections for collisions involving heavy particles are considered in the first Born approximation. The impact parameter and semi-classical treatments are compared with the wave treatment. It is proved that the cross sections given by the three treatments are effectively equal even at moderate and low impact energies. The very slight differences that exist are decreased if the cross section is summed over final-state and averaged over initial-state spatial degeneracies. To illustrate the position some specific transitions are examined in detail. (auth)

27759 RESONANCE TRANSFER OF EXCITATION. Gomberoff, L.; Power, E. A. (University Coll., London). Proc. Phys. Soc. (London), 88: 281-4(June 1966).

The effect of retardation on the spatial dependence of the rate of resonance transfer of excitation is calculated by S-matrix theory. The Förster transition rate, proportional to R^{-6}, is the limiting case when the radiator and acceptor molecules are separated by a distance R smaller than $\frac{1}{2}\pi$ times the wavelength of the light involved in the transition. The dependence on R for separations of the order of and larger than λ is given, following Avery, and the connection is shown to the retarded potential energy between the resonating systems. (auth)

27760 RELATIVISTIC CORRECTIONS TO THE EIGENVALUES OF THE 2 $^{1,3}S$ STATES OF THE HELIUM SEQUENCE. Stewart, A. L. (Queen's Univ., Belfast). Proc. Phys. Soc. (London), 88: 311-14(June 1966).

The relativistic corrections to the eigenvalues of the 2 $^{1,3}S$ states of the helium sequence are determined exactly

to $O(Z^3\alpha^2)$ using perturbation theory. The results require a small correction of order $(Z^2\alpha^2)$ to fit the very accurate values for helium and Li^+ calculated by Pekeris. (auth)

27761 REGULARITIES AND ANOMALIES IN THE ISOTOPE SHIFTS IN THE ARC SPECTRUM OF BARIUM. Jackson, D. A.; Tuan, Duong Hong (CNRS, Bellevue, France). Proc. Roy. Soc. (London), Ser. A, 291: No. 1424, 9-17(Mar. 29, 1966).

The isotope shifts in the lines 3072 and 3501 Å of the arc spectrum of barium were determined from measurements of differences of the wavelengths of these lines emitted by enriched isotopes in a hollow-cathode tube. A revision of earlier measurements of the shifts in the line 5536 Å was made on the basis of measurements made with atomic beams and with the hollow cathode tube with more highly enriched isotopes. The shifts relative to the isotope 138 are given. It is shown that when the volume shifts and the mass shifts are separated, the anomalous distribution of the shifts disappears in the case of the isotopes of even mass number, but an unusually large staggering of the shifts of the odd isotopes remains. (auth)

27762 STATISTICAL THEORY OF SPIN RELAXATION. II. Nakano, Huzio (Nagoya Univ., Japan). Progr. Theoret. Phys. (Kyoto), 35: 214-27(Feb. 1966).

The statistical theory of spin relaxation recently developed is supplemented in one important respect. In the expression for the local fluctuating field acting on a magnetic moment the neighboring magnetic moment which causes the local field is involved. Therefore the local field cannot be regarded as a stochastic process, given a priori, in determining the stochastic temporal development of the magnetic moment, but it is necessary to determine it in a self-consistent way. This is undertaken. The cases in which two dissimilar moments interact with each other and in which two similar moments interact with each other are discussed separately. In each case the Bloch equation is obtained on suitable assumptions, and concrete expressions for the longitudinal and transversal relaxation times are obtained. (auth)

27763 DOUBLE CHARGE EXCHANGE OF LOW-ENERGY SINGLY CHARGED POSITIVE IONS. Kozlov, V. F.; Bondar, S. A. (Inst. of Physics and Technology, Academy of Sciences, Ukrainian SSR). Zh. Eksp. Teor. Fiz., 50: 297-306(Feb. 1966). (In Russian).

The double charge exchange effective cross sections for H^+, Li^+, Na^+, and K^+ ions in a number of gases were measured at energies between 150 and 6000 ev by a method which takes into account experimentally the error due to unequal scattering of the primary and secondary particles. A function that fits the data for each ion-atom or ion-molecule pair was obtained. It was found that the curve for this function can be described by a single empirical formula throughout the whole velocity interval considered. (G.O.Y.)

27764 EFFECTIVE CROSS SECTION FOR INELASTIC COLLISIONS BETWEEN SLOW ELECTRONS AND CESIUM ATOMS IN THE PRE-THRESHOLD REGION. Korchevoi, Yu. P.; Przhonskii, A. M. (Kiev State Univ.). Zh. Eksp. Teor. Fiz., 50: 315-19(Feb. 1966). (In Russian).

The cross section for excitation of the Cs atom by electron impact to the 6 $p_{\frac{1}{2},\frac{3}{2}}$ and 7 $p_{\frac{1}{2},\frac{3}{2}}$ levels was measured by the electron-trap method in the pre-threshold region. The slope of the initial linear part of the first curve is 1.5×10^{-14} cm^2/ev. The measured values of the inelastic collision cross sections are compared with the results of theoretical calculations and also with the total cross section for interaction between electrons and Cs atoms. (auth)

27765 SPECTROSCOPIC INVESTIGATION OF ELASTIC SCATTERING OF SLOW ELECTRONS ON CESIUM AND ARGON ATOMS. Mazing, M. A.; Vrublevskaya, N. A. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz., 50: 343-8(Feb. 1966). (In Russian).

The shift of the cesium absorption lines near the series edge due to the action of cesium or argon is measured. The results are compared with the theoretical values for the electron elastic scattering amplitude on cesium or argon atoms in the ~0.005 to 0.05 ev electron energy range. A value of the electron elastic scattering cross section at zero energy is obtained by extrapolating the measured shift to the series edge. (auth)

Cosmic Radiation

See *also* Elementary Particles and Radiations
Nuclear Properties and Reactions

Refer also to abstracts 28137 and 28138.

27766 (MURA-718) A SEARCH FOR MASSIVE PARTICLES IN COSMIC RAYS. Dayton, B.; Mills, F.; Radmer, C. (Midwestern Universities Research Association, Stoughton, Wis.); Jones, L. W. (Michigan Univ., Ann Arbor); Camerini, U.; Good, M. L.; Subramanian, A. (Wisconsin Univ., Madison). Apr. 18, 1966. Contracts AT (11-1)-718; NONR-1224(23). 28p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

A search for long-lived particles ($\gtrsim 10^{-6}$ sec) of mass in the range of about 5 to 15 Bev was carried out among cosmic rays at the summit of Mt. Evans, Colorado, by measuring time intervals between the arrival of strongly interacting particles of energy $\gtrsim$ 70 Bev and accompanying air shower particles. From the absence of delayed strongly interacting particles in the range 40 to 180 ns where particles of nucleonic mass are not allowed, it is concluded that an upper limit of 160 μb/nucleon could be placed on the cross section for production of particles of mass around 8 Bev at energies not far above threshold in nucleon-nucleon collisions. This limit is subject to certain restrictive assumptions about the behavior of the hypothetical massive particles, which are discussed. (auth)

27767 CHARGE SPECTRUM AND INTERACTIONS OF RELATIVISTIC HEAVY NUCLEI IN THE PRIMARY COSMIC RADIATION. Judek, B.; Van Heerden, I. J. (National Research Council, Ottawa). Can. J. Phys., 44: 1121-45(May 1966). (NRC-8918).

The charge spectrum of relativistic heavy nuclei in the primary cosmic radiation was investigated in a stack of nuclear emulsions exposed over Texas at a ceiling height of 136,000 ft. Charges of 601 primary and of 203 fast secondary nuclei arising from fragmentations were determined. Using a "range" criterion to count δ rays, charge resolutions up to Z = 15 were obtained. All of the tracks were followed through the stack and the interaction mean free paths in emulsion and the fragmentation probabilities evaluated for individual elements up to Z = 15. Using these probabilities, the relative abundances at the top of the atmosphere were 12.7 ± 1.3% L nuclei ($3 < Z < 5$), 63.5 ± 3.5% M nuclei ($6 < Z < 9$), 13.6 ± 1.6% H_3 nuclei ($10 < Z < 15$), 1.7 ± 0.5% H_2 nuclei ($16 < Z < 19$), and 8.5 ± 1.4% H_1 nuclei ($Z > 20$). It was found that the interaction mean free paths in emulsion of the M and H nuclei were about 10% lower than previous experimental and calculated values. The fragmentation probabilities were generally in agreement with previous determinations, except for a significantly high value for the fragmentation of H_1 to L nuclei. (auth)

27768 ORIGIN OF COSMIC RAYS. ter Haar, D. (Oxford Univ.). Contemp. Phys., 6: 338-48(June 1965).

A brief survey of the available data pertaining to cosmic ray nuclei with energies above 1 Bev and an outline of a galactic theory concerning the origin of these cosmic rays are presented. According to the proposed theory, the cosmic rays in question are produced in supernovae, and their properties—such as chemical composition, energy spectra and spatial distribution—are determined partly by their acceleration in and ejection from the sources and partly by various physical processes occurring during the passage of the cosmic rays from their sources to the earth. (Int. Aer. space Abstr.)

27769 RADIATION BELTS OF THE EARTH. Vernov, S. N.; Chudakov, A. E.; Gorchakov, E. V.; Logachev, Iu. I.; Nesterov, V. E.; Savenko, I. A.; Shavrin, P. I. Geofiz. Biul., No. 14, 96-109(1965). (In Russian).

A review is given of the history of discovery of the earth's radiation belts, tracing it to anomalous radiation data provided by Soviet satellites since November 7, 1957. These data are discussed and are illustrated by graphs of scintillation counter readings taken by the third Soviet satellite in the polar regions. Diagrams of the location in geographical coordinates of the outer and inner radiation belts in the Northern and Southern Hemispheres are plotted from satellite data. Cosmic radiation data from the Mars 1 and Luna 4 stations are also given in diagrams. (Int. Aerospace Abstr.)

27770 COSMIC RAY VARIATIONS IN THE IGY PERIOD AND THE ELECTROMAGNETIC PROPERTIES OF SPACE. Dorman, L. I. Geofiz. Biul., No. 14, 116-27(1965). (In Russian).

A discussion is given of some results of cosmic radiation studies conducted in the USSR as part of the IGY program. Types and the nature of cosmic radiation variations, notably the 11-year variations, the Forbush effect as a characteristic of individual magnetic storms, the propagation of solar particles in space, and the causes of cosmic radiation anisotropy are the main topics of the discussion. The distribution of magnetic fields in the Galaxy is seen to be a factor substantially determining (1) the amplitude of cosmic radiation anisotropy, (2) its dependence on the energy of primary particles, and (3) the energy spectrum and nuclear composition of cosmic radiation. (Int. Aerospace Abstr.)

27771 EFFECT OF THE BOUNDEDNESS OF THE GEOMAGNETIC FIELD ON COSMIC RAYS. Asaulenko, L. G.; Dorman, L. I.; Smirnov, V. S.; Tyasto, M. I. (Polar Geophysical Inst., Academy of Sciences, USSR). Geomagn. Aeronomy (USSR)(Engl. Transl.), 5: 629-34(1965).

Translated from Geomagn. Aeronomiya, 5: 809-16(1965).

The effect of magnetosphere compression on cutoff rigidities and in asymptotic directions is examined. It is shown that compression leads to an increase of the influence of the magnetic field on cosmic rays and that the combined effect of the boundedness of the magnetosphere and of the westerly current system leads to a weakening of the influence of external sources on cutoff rigidity and on asymptotic directions. (auth)

27772 STUDY OF COSMIC-RAY ANISOTROPY WITH CROSSED TELESCOPES. Skripin, G. V.; Krivoshapkin, P. A.; Krymskii, G. F.; Filippov, V. A. (Research Inst. of Space Physics and Aeronomy, Academy of Sciences, USSR). Geomagn. Aeronomy (USSR)(Engl. Transl.), 5: 635-41(1965).

Translated from Geomagn. Aeronomiya, 5: 817-25(1965).

A method is proposed for taking into account the distortions of cosmic-ray anisotropy by the geomagnetic field and the radiation pattern of the instrument. Matrices are computed which restore the true anisotropy vector for the equipment at Yakutsk. The computations are made using coupling coefficients under various zenith angles and three types of energy spectra of anisotropy. The matrices are used to restore the true anisotropy vectors with respect to the neutron component for three solar activity epochs (1958-1964). Telescope azimuth readings are used to find the true vectors and the vectors of the atmospheric effect for the surface of the earth and for depths of 7.20 and 60 Mwe. The degree of agreement of the vectors obtained with three types of energy spectra is estimated. (auth)

27773 STUDY OF SPECTRA OF FORBUSH-TYPE DECREASES OF COSMIC-RAY INTENSITY AS A FUNCTION OF SOLAR ACTIVITY. Kolomeets, E. V.; Pivneva, V. T. (Kazakh State Univ., USSR). Geomagn. Aeronomy (USSR)(Engl. Transl.), 5: 642-5(1965).

Translated from Geomagn. Aeronomiya, 5: 826-30(1965).

Several characteristic Forbush effects that occurred from 1957 to 1962 are investigated. The energy spectra during the decrease and recovery are computed. It is shown that the spectrum changes rather sharply during a single Forbush effect. No definite pattern was found in the variation of energy spectra of Forbush effects with solar activity variation. The rate of change of cosmic-ray intensity during the decrease and recovery of Forbush effects depends on the direction of particle arrival. (auth)

27774 ALLOWANCE FOR THE EFFECT OF CURRENTS IN RADIATION BELTS ON THE CUTOFF RIGIDITY OF COSMIC RAYS. Dorman, L. I.; Tyasto, M. I.; Smirnov, V. S. (Polar Geophysical Inst., Academy of Sciences, USSR. Inst. of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, Academy of Sciences, USSR). Geomagn. Aeronomy (USSR)(Engl. Transl.), 5: 713-17(1965).

Translated from Geomagn. Aeronomiya, 5: 913-17(1965).

The effect on cosmic ray cutoff rigidity of currents distributed over the surface of a shell formed by the rotation of a line of force of the magnetic dipole about its axis is investigated. The latitudinal dependence of the difference between the cutoff rigidity in a dipole field and the computed cutoff rigidity is given. It is shown that the cutoff rigidity for the cosmic ray particles for the given current density decreases most strongly at middle latitudes. Also the cutoff rigidity decreases as the radius of the current shell increases since as the radius of the current shell increases at a given current density the total force of the current in the current shell increases as a result of the increase of its area. (J.F.P.)

27775 POSSIBILITY OF DETERMINING THE AMPLITUDE OF THE REGULAR DIURNAL VARIATION OF COSMIC-RAY INTENSITY. Kuklin, G. V.; Luzov, A. A. (Inst. of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, Academy of Sciences, USSR). Geomagn. Aeronomy (USSR)(Engl. Transl.), 5: 717-19(1965).

Translated from Geomagn. Aeronomiya, 5: 918-20(1965).

The parameters of diurnal variation of cosmic ray intensity and the determination of the amplitude of the diurnal wave are found using autocorrelation functions of random processes. Computations for structural functions including the use of autocorrelation functions because of the linear relation between them are given. The results of the computations for the amplitude of the regular periodic component based on neutron monitor data obtained at Munich for January to March, 1961, are given. It is concluded that for reliable determination of the regular diurnal wave in cosmic ray intensity it is sufficient to compute the autocorrelation or structural functions three times. Thus the method can be used to determine the amplitudes of diurnal variations for a latitude profile of stations and to trace the time pattern of the variation structure. (J.F.P.)

27776 MEASUREMENT OF 210-kc AND 2200-kc COSMIC RADIO EMISSION AT A DISTANCE OF 8 EARTH RADII BY THE ZOND-2 INTERPLANETARY STATION. Slysh, V. I. Kosm. Issled., 3: 760-7(Sept.-Oct. 1965). (In Russian).

The intensity of the distributed cosmic radio emission at frequencies of 210 and 2200 kc, measured on the automatic interplanetary station Zond-2 at distances up to 8 earth radii, is equal respectively to 2.7×10^{19} and 1×10^{20} w/m^2/cps/sterad. A profile of the electron density in the vicinity of the earth (up to $R = 7R_E$) was obtained, which can be described by the function $1.3 \times 10^5 (R_E/R)^4$ electrons/cm^3. The effect of plasma and magnetic field on the parameters of the receiving antenna is shown. (tr-auth)

27777 COSMIC-RAY ASTRONOMY. Winn, M. M. (Univ. of Sydney). New Sci., 30: 24-6(Apr. 7, 1966).

Problems involved in identifying individual sources of cosmic rays in the sky are reviewed. The construction and operation of the proposed Sydney University Giant Air-shower Recorder (SUGAR) are discussed. The initial SUGAR air-shower array will consist of 25 stations, each with two plastic scintillation counters, extending over an area of 25 km^2; the array is eventually intended to cover 260 km^2. (M.J.T.)

27778 COSMIC-RAY INTENSITIES UNDER SEA-WATER AT DEPTHS DOWN TO 1400 m. Higashi, S.; Kitamura, T.; Miyamoto, S.; Mishima, Y.; Takahashi, T.;

Watase, Y. (Osaka City Univ.). Nuovo Cimento (10), 43A: 334-46(May 21, 1966).

There is a disagreement between the muon energy spectrum observed at sea level and the one evaluated from the depth-intensity relation of cosmic rays below ground by using the theoretical expression for energy loss of the muon traversing the rock. As the cause of this fact, one can point out following two reasons: uncertainties in the determination of the compositions of the rocks or imperfection of the theoretical expression for energy loss. To decide this point, the cosmic-ray intensities were measured at various depths up to 1380 m in the ocean where the composition of the water is well known and the uniformity is well certified. The observed result is in excellent agreement with the sea-level energy spectrum in the corresponding energy region, the current energy loss formula being taken into account. From this fact, it is pointed out that the previous observations of range spectra underground suffered from ambiguities due to uncertainties in the composition of the rocks. (auth)

27779 BALLOON OBSERVATION OF THE ISOTROPIC COMPONENT OF CELESTIAL X RAYS UP TO 90 kev. Bleeker, J. A. M.; Burger, J. J.; Scheepmaker, A.; Swanenburg, B. N.; Tanaka, Y. (Royal Dutch Academy of Sciences, Delft, Netherlands). Phys. Lett., 21: 301-3(May 15, 1966).

The spectrum of isotropic celestial x rays over the energy range 26-90 kev is obtained. A periodically operating shutter was employed for separating the celestial x rays from the cosmic ray induced background. The present result does not confirm the hypothesis of thermal radiation. (auth)

27780 COSMIC-RAY NEUTRONS NEAR THE EARTH. Hendrick, L. D.; Edge, R. D. (Univ. of South Carolina, Columbia). Phys. Rev., 145: 1023-5(May 27, 1966).

The altitude distribution of cosmic-ray neutrons was measured from ground level up to 1175 ft using BF_3 detectors on a television antenna tower. Neutrons of about 1-kev energy were measured by surrounding the BF_3 counters with cadmium-coated polyethylene cylinders. The flux near the earth was found to depend strongly on the soil water content. The distribution of neutrons below 1 ev was found from the difference in count rates of bare and cadmium-covered detectors and agrees with the result of a diffusion calculation. The neutron energy spectrum was investigated at the 45- and 1175-ft levels by counting with varying thicknesses of polyethylene surrounding the detectors, but little difference between the spectra for the two levels was discernible. (auth)

27781 EFFECT OF ADIABATIC DECELERATION ON THE COSMIC RAY SPECTRUM IN THE SOLAR SYSTEM. Parker, E. N. (Univ. of Chicago). Planet. Space Sci., 14: 371-80(Apr. 1966).

Cosmic rays in the magnetic fields carried in the solar wind are continually expanded and decelerated, in addition to being convected out of the solar system. The effect of the deceleration on the cosmic ray spectrum is calculated for the case that the outward convection of cosmic rays is small and for the case that the cosmic ray spectrum is a simple power law and the diffusion coefficient is independent of energy. The calculations are carried out for both particle momentum and energy. It is shown that a power law spectrum is preserved by the deceleration. It is shown that the deceleration contributes a decrease at high energies of about one third of the total modulation. Where the spectrum flattens out at lower energies, the deceleration produces an increase which partially cancels the reduction by convection. (auth)

27782 INVESTIGATION OF COSMIC RAYS UNDERGROUND USING A SCINTILLATOR STACK. III. MUON INTERACTIONS AND THE RESULTING CASCADE SHOWERS. Barton, J. C. (Northern Polytechnic, London). Proc. Phys. Soc. (London), 88: 355-71(June 1966).

The data on muon interactions occurring in the scintillator stack have been analyzed so that the average shower development for showers of each size could be determined. This makes it possible to determine the muon interaction rates with greater certainty. Further data on higher energy showers are presented and the probabilities of muons producing showers with energies over the range from 0.1 to 100 Bev calculated. The results agree with the theories for knock-on and bremsstrahlung by muons over this energy range. The average cascade shower behavior agrees with analytical and Monte Carlo theories up to 10 Bev; at higher energies the agreement is poorer, possibly owing to geometric effects or to the inhomogeneous nature of the absorber. (auth)

27783 CHANGES IN COSMIC-RAY RIGIDITY SPECTRUM DURING COSMIC-RAY STORMS ASSOCIATED WITH GEOMAGNETIC DISTURBANCES. Takahashi, Hachiro (Iwate Univ., Morioka, Japan). Rep. Ionosphere Space Res. Jap., 19: 389-407(1965).

The changes in the cosmic-ray rigidity spectrum during cosmic-ray storms are studied statistically by using various cosmic-ray data and geomagnetic data. The results obtained show that the changes in the rigidity spectrum closely correlate with the magnitudes of geomagnetic disturbances associated with cosmic-ray storms. They also show that the slope of the latitude dependence curve of cosmic-ray intensity at the time of cosmic-ray storms is dependent on the magnitude of associated geomagnetic disturbances. These results are confirmed by using the cosmic-ray rigidity spectra obtained previously. It is concluded that the results are caused not by the change in geomagnetic cut-off, but by a modulation effect in interplanetary space by the solar magnetic cloud, and a possible mechanism is suggested. (auth)

27784 ENERGY SPECTRA OF COSMIC MUONS AT LARGE ZENITH ANGLE. Borog, V. V.; Kirillov-Ugryumov, V. G.; Petrukhin, A. A.; Rozental', I. L.; Shestakov, V. V. (Moscow Engineering Physics Inst.). Yadern. Fiz., 3: 783-4(Apr. 1966). (In Russian).

The energy spectrum of cosmic muons at zenith angles $\geq 55°$ and energies from 2×10^{11} to 3×10^{12} ev was measured, by recording muon-initiated cascade showers using an ionization calorimeter arrangement. Analysis of 830 showers having the required parameters was carried out. The measured integral energy spectrum of the showers was compared with the calculated spectrum, for various assumptions on the muon spectrum. The muon spectrum was assumed to be in the form $I(E) = I_0E^{-\gamma}$, and account of bremsstrahlung, delta-electron formation, and variation of recording probability with shower energy was taken. Estimates of I_0 and γ were made for the vertical spectrum by taking into account superhigh-energy muon angular distributions calculated previously, for the cases when the muon source is only pions or only kaons. (M.J.T.)

Direct Energy Conversion

27785 (FEI-27) NEKOTORYE PROBLEMY RAZRABOTKI TERMOZMISSIONNOGO REAKTORA-PREOBRAZOVATELYA. (Certain Problems in the Design of a Thermionic Emission Converter-Reactor). Pupko, V. Ya.; Malykh, V. A.; Gusakov, I. M.; Petrovskii, V. G.; Dmitriev, V. M.; Yur'ev, Yu. S. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). 1965. 17p. Dep. mn.

Fission heat can be directly converted to electrical energy by heating up an electron emitter cathode in direct contact with fissile materials to a temperature of 1400 to 2000°C. A concentric collector of some refractory material is used with cesium vapor in the gap. A fast neutron reactor has a specific electrical power of 10 to 30 kilowatts/liter at a cathode temperature of 1800 to 2000°C. The heat flux depends strongly on the ^{235}U concentration. Power leveling can be achieved by varying the ^{235}U concentration in the core. The specific power of a slow neutron reactor is considerably less than that of a fast neutron reactor. Zirconium hydride $ZrH_{1,5}$ can be used as a moderator. The size of the reactor core and ^{235}U requirements are plotted

as a function of the volume percent of the moderator in the core and of the uranium concentration in the converter. Minimum reactor size is obtained at 0.7 volume fraction of moderator in the core. A discussion of the electrical and thermal losses is presented. Converters made of UC + ZrC without cladding and with an NbC cladding, and of UO_2 with Mo cladding were placed in a reactor for testing. A three-element assembly consisted of series-connected rods each 20 mm long. The cathode material was Mo. The anode was Nb. The interelectrode gas was ~0.5 mm. Typical volt-ampere characteristics are presented. Calculated surface temperatures are compared with the experimental values. (TTT)

27786 (IPP-3/37) LEISTUNG EINES MHD-GENERATORS UNTER BERUECKSICHTIGUNG VON HALL-EFFEKT UND IONENSCHLUPF. (Power Density of a MHD Generator Considering Hall Effect and Ion Slip). Ohlendorf, W. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Mar. 1966. 33p. Dep. mn.

From the theory of MHD generators, the power output of the usual generator types was calculated for the two cases of constant and variable conductivity, taking into consideration the Hall effect and the ion slip. (auth)

27787 (TID-22303) TEST DATA CELL CONCEPT AND PROGRAM STATUS. Koch, R. L.; Karas, H. R. (Allison Div., General Motors Corp., Indianapolis, Ind.). Dec. 1963. Contract AT(30-1)-3132. 139p. (EDR-3660). Dep. mn. CFSTI $4.00 cy, $1.00 mn.

The combined cell concept is dependent on mutual development of the Liquid Metal Cell (LMC) and the Gas Amalgam Cell (GAC). The combination of these two units into an engineering test data cell will derive design data for a prototype combined cell. The program status with respect to various tasks which must be completed in order to produce an operating combined cell is presented. The concept of a test data cell is shown along with a schematic representation of a combined cell. An analysis of the LMC and the GAC along with equations for discharge and charge operation of these units is included. The operation of the test data cell is projected on the basis of improvements predicted for six months and twelve months hence. (auth)

27788 (UCRL-16804) WORK FUNCTION AND CESIUM DESORPTION ENERGIES FOR PLANAR TUNGSTEN SINGLE CRYSTALS. Koenig, Daniel R.; Pigford, Thomas H. (Lawrence Radiation Lab., Univ. of California, Berkeley). Apr. 1966. Contract W-7405-eng-48. 22p. (CONF-660324-1). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From 26th Annual Conference on Physical Electronics, Cambridge, Mass.

The work functions of bare, planar, tungsten crystals were determined in vacuum diodes from measurements of the field-free thermionic emission in the temperature range 1400 to 2200°K. The work function ϕ_0 and Richardson constant A for crystals oriented in the (110) and (100) directions are: $\phi_0(110) = 5.33 \pm 0.04$ eV, $A(110) = 207 \pm 50$ amperes/cm^2 °K; $\phi_0(100) = 4.65 \pm 0.02$ eV, $A(100) = 238 \pm 75$ amperes/cm^2 °K^2. The desorption energies ϕ_{io} and ϕ_{ao} of cesium ions and atoms evaporating from a (100) tungsten surface at low coverage were determined by measuring transient ion currents resulting from the sudden polarity reversal of an applied electric field at the crystal surface. The results, obtained in the temperature range 1000 to 1500°K, are: $\phi_{io} = 2.05 \pm 0.05$ ev and $\phi_{ao} = 2.77 \pm 0.05$ eV. These desorption energies are consistent with the observed (100) work function and are essentially identical with the data of Taylor and Langmuir for polycrystalline tungsten obtained by a different technique. (auth)

27789 (UCRL-16805) WORK-FUNCTION DEPRESSION AND SURFACE IONIZATION FOR PLANAR (100) TUNGSTEN EXPOSED TO CESIUM. Koenig, Daniel R.; Pigford, Thomas H. (Lawrence Radiation Lab., Univ. of California, Berkeley). Apr. 1966. Contract W-7405-eng-48. 12p. (CONF-660324-2). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From 26th Annual Conference on Physical Electronics, Cambridge, Mass.

Currents due to electron and ion emission were measured in a cesium diode with a planar monocrystalline (100) tungsten emitter as a function of applied voltage, emitter temperature (850 to 1450°K), and cesium reservoir temperature (0 to 100°C). The work-function depression due to cesium adsorption was evaluated from field-free electron emission data by means of the Richardson equation and from field-free ion emission data by means of the Saha-Langmuir equation. Results from the two methods agree within 2% for emitter temperatures below the threshold temperature for ionization. The threshold temperature occurs at an emitter-to-cesium reservoir temperature ratio of 3.5. Work function depressions as great as 2.9 ev, corresponding to an inferred cesium coverage of 0.6–0.7 of a monolayer, were obtained. The variation of work function with emitter-to-cesium-reservoir temperature ratio agreed reasonably well with theory. (auth)

27790 DIRECT CURRENT LIQUID-METAL MAGNETOHYDRODYNAMIC POWER GENERATION. Elliott, David G. (California Inst. of Tech., Pasadena). AIAA (Amer. Inst. Aeron. Astronaut.) J., 4: 627-34(Apr. 1966).

A constant-pressure d-c magnetohydrodynamic generator was tested with NaK at inlet velocities up to 300 fps. The maximum output power was 10.8 kw (18,250 amp at 0.59 v), and the efficiency was 48%. The theoretical efficiency, considering ohmic heating, fluid friction, boundary-layer shunting, and end effects, was 58%. The theoretical ultimate efficiency of liquid-metal MHD generators, of the type considered, ranges from 60 to 70%. (auth)

27791 SELF-EXCITED EXPLOSIVE-DRIVEN MHD GENERATOR. Loeffler, A. L. Jr.; Aronowitz, L.; Ericson, W. B. (Grumman Aircraft Engineering Corp., Bethpage, N. Y.). AIAA (Amer. Inst. Aeron. Astronaut.) J., 4: 942-4 (May 1966).

A self-excited explosive-driven MHD generator is described which has a minimum of weight for possible space applications and does not require an externally produced magnetic field. (B.G.D.)

27792 OPTIMUM ELECTRODE ARRANGEMENT IN A MAGNETOHYDRODYNAMIC CHANNEL TAKING THE HALL EFFECT INTO ACCOUNT. Haeusler, Jochen (Technische Hochschule, Stuttgart). Arch. Elektrotech. 50: 74-84(1965). (In German).

Analysis showing that for an MHD channel with one pair of electrodes and with rows of segmented electrodes, at constant channel height and arbitrary magnetic field, the anode resistance will have a minimum if the electrodes are not shifted with respect to each other. This is seen to contradict the techniques found in the literature, which propose electrode shifting as a means of increasing the output power of an MHD channel. (Int. Aerospace Abstr.)

27793 FUNDAMENTALS OF THERMIONIC ENERGY CONVERSION. Richards, Hans Kohn. Argonne Nat. Lab. Rev., 3: 21-6(Jan. 1966).

Basic concepts of thermionics and energy conversion in thermionic cells are summarized. Computations of energy losses and converter efficiency are considered. Set-ups for experiments with thermionic diodes are described. The volt-ampere characteristics of cesium, potassium, and sodium low pressure cells are shown. High pressure cells and volume ionization are discussed. Materials used in thermionic fuel cells are considered. (M.J.T.)

27794 HEAT-PIPES AND THEIR APPLICATION FOR NUCLEAR POWER SUPPLIES IN SPACE. Neu, H. (EURATOM, Ispra, Italy). Atompraxis, 12: 220-4(Apr.-May 1966). (In German).

Heat-pipes are closed tube structures, wherein heat is transported by evaporation and condensation of liquids. The

condensate flows back to the heating zone along small grooves inside the tube walls, propelled by the capillary forces. This new heat removal system also works well in gravity free space and shows very little temperature drop between the heating and cooling zone (some degrees.) A review is given of the theoretical and experimental work carried out at Ispra. Possible combinations of tube material and working fluid and the physical and technological properties of heat-pipes are treated. Heat-pipes can be used for the heat supply to, and the heat removal from thermionic energy converters. A first experimental unit of this kind showed the expected properties. The advantages and disadvantages of a thermionic reactor concept for space using three different kinds of heat-pipes are discussed. The use of heat-pipes may also lead to special advantages for energy supplies with radioisotopes and thermionic converters. (auth)

27795 PRELIMINARY EVALUATION OF CERIA-LANTHANA AS A SOLID ELECTROLYTE FOR FUEL CELLS. Singman, David (Harry Diamond Labs., Washington, D. C.). J. Electrochem. Soc., 113: 502-4(May 1966).

Preparation and evaluation of a solid solution of 85 mole % CeO_2 and 15 mole % La_2O_3 as a solid electrolyte for fuel cells are discussed. Its electric conductivity and cell voltage-current curves were compared with those for $CaO-ZrO_2$. The open-circuit voltage obtained at different voltages and temperatures is discussed. Changes in open-circuit voltage after current was drawn indicated a change in the electrolyte composition. Therefore the $CeO_2-La_2O_3$ solid solution is probably not suitable for use as solid electrolyte in fuel cells. (F.J.H.)

27796 LIQUID-METAL MHD GENERATORS WITH LARGE MAGNETIC REYNOLDS NUMBERS. Mikhailov, Yu. M. Magnit. Gidrodin., No. 4, 113-19(1965). (In Russian).

Certain problems associated with the operation of MHD generators at high magnetic Reynolds numbers are studied. The results obtained are relevant to the design of the high power generators of planar and cylindrical types. Ohm and Maxwell equations are solved for the magnetic fields in a regime of Reynolds numbers greater than unity for both types of generators with the account of finite length of the working region. The velocity distribution is assumed to be known. The solution shows that the magnetic field distribution depends on the magnitude of the Reynolds number and on the geometry of the working section of the generator. At high Reynolds numbers the penetration of the magnetic field is decreased, causing a drop in the magnetic field amplification factor. This imposes a restriction on the length of the working region and on the thickness of the liquid metal sheet. (ATD)

27797 EXPERIMENTAL INVESTIGATION OF A LOW-VOLTAGE HOMOPOLAR GENERATOR USED AS A POWER SUPPLY FOR d-c CONDUCTION PUMPS. Aliyevskii, B. L.; Bertinov, A. I. Magnit. Gidrodin., No. 4, 125-9(1965). (In Russian).

The characteristics of a homopolar generator operating at low voltage are described. The generator construction and a detailed description of the liquid metal contacts with argon pressurization are given. The generator load was simulated by water-cooled steel tubes with a switching mechanism allowing changes in the load resistance. Generator testing (at 3000, 6000, 9000 rpm) consisted of measuring power losses in various sections of the generator and determining efficiency as a function of rotation speed and load value. It is shown that friction losses in each contact increase rapidly (from 60 w to 1120 w) as rotation increases; internal electric losses are about 50 w and losses in field coils are 150 w; at the lowest speed, mechanical losses constitute 150 w. It is also shown that the efficiency increases rapidly with increasing output power and reaches a value of about 80%, with the most efficient operation occurring at 3000 rpm. Graphics also show the regulation characteristics. It is recommended that liquid NaK be used in place of the denser mercury in the contacts to increase efficiency. (ATD)

27798 ELECTRIC DISCHARGE IN A MAGNETIC FIELD BETWEEN ONE MOVING AND ONE STATIONARY ELECTRODE. Yantovskii, L. I. Magnit. Gidrodin., No. 4, 130-6(1965). (In Russian).

The possibility of creating a continuous flow of current between two electrodes (one of which is moving at high velocity) by means of an arc discharge is demonstrated. The experimental apparatus, shown in a block diagram, consists of a revolving steel disc electrode (moving at 20,000 rpm) and a stationary copper ring electrode. This system of electrodes is placed between the poles of an electromagnet with the field parallel to the axis of the electrodes. The entire apparatus was placed in a vacuum jar where the initial pressure was 10^{-2} mm Hg and maintained at a maximum of 1 mm Hg. Oscilloscope monitoring of the current was used to evaluate the performance of the revolving electrodes. The voltage developing across the discharge was 10 v. It is concluded that it is practical to use such relatively long discharges (1 mm) to maintain current flow in such machines as homopolar generators. (ATD)

27799 FUNDAMENTAL INVESTIGATIONS OF AN ALTERNATING CURRENT MAGNETOHYDRODYNAMIC GENERATOR WITH ELECTRODES. Hayashi, Shigenori; Hattori, Yoshio; Umoto, Juro. Tech. Rep. Eng. Res. Inst., Kyoto Univ., No. 126, 1-15(Apr. 1966).

The expressions of the generated and output powers, the ohmic and eddy current losses, the electric efficiency, and the other main quantities of an a-c MHD generator with electrodes are presented. Then the conditions for maximizing the total output power or the efficiency thereof are derived, and by means of setting forth the several examples, it is suggested that possibly the present type generator will be brought to practical use. (auth)

27800 METHOD AND MEANS FOR IMPROVING THE ELECTRON EMISSION FROM A REFRACTORY CONDUCTING MATERIAL. Aamodt, Rodney L.; Brown, L. J.; Nichols, B. D. (to U. S. Atomic Energy Commission). U. S. Patent 3,246,196. Apr. 12, 1966.

This is an improvement in thermionic emitters wherein both cesium and fluorine are made available for coating the emitter during operation. (AEC)

Elementary Particles and Radiations

See also Field Theory, Scattering Theory, and Symmetries

Refer also to abstracts 27278, 28152, 28460, and 28643.

27801 (IC-66/47) ALGEBRA OF CURRENTS AND ω-ϕ MIXING ANGLE. Khanna, M. P.; Vaidya, A. (International Centre for Theoretical Physics, Trieste (Italy)). May 11, 1966. 9p. Dep. mn.

The equal time commutation relations of integrated currents are applied to the ω-ϕ system. In particular, the value of the ω-ϕ mixing angle is deduced. Some of these results are used to test the models of elementary particles as proposed by Okubo, showing the Gell-Mann-Zweig quark model is more favorable to the Maki-Hara quark model. (auth)

27802 (ISS-66/2) PRELIMINARY STUDY OF AN ELASTIC SCATTERING EXPERIMENT TO BE PERFORMED AT ADONE. Amaldi, U. Jr.; Biancastelli, R.; Stein, P. (Istituto Superiore di Sanita', Rome (Italy). Laboratori di Fisica). Feb. 14, 1966. 26p. Dep. mn.

On the same line of a recently performed statistical analysis of electrodynamical experiments and as a first step towards a definite proposal, various possible ways of studying the reaction $e^+ + e^- \rightarrow e^+ + e^-$ are discussed. Experiments both without and with magnetic field are considered and the information obtained distinguishing the charges without momentum measurement are analyzed. (auth)

27803 (LNF-66/17) A NOTE ON DOUBLE BREMSSTRAHLUNG. Note No. 316. di Vecchia, P. (Laboratori Nazionali di Frascati, Comitato Nazionale per l'Energia Nucleare (Italy)). Mar. 30, 1966. 5p. Dep. mn.

Double bremsstrahlung produced in colliding beam facilities by the $e^+ + e^- \rightarrow e^+ + e^- + 2\gamma$ collision is discussed. The following monitoring processes are compared: backward-forward two quanta annihilation, small angle e^+e^--scattering, and single e^+e^- bremsstrahlung. (M.O.W.)

27804 (UCRL-16767) ANALYSIS OF PROTON-ALPHA CROSS SECTION AND POLARIZATION DATA FROM 20 TO 60 Mev. Conzett, H. E. (Lawrence Radiation Lab., Univ. of California, Berkeley). Mar. 1966. Contract W-7405-eng-48. 22p. (CONF-660107-39). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From American Physical Society Meeting, New York.

A review is presented of a p–α elastic scattering research dealing with differential cross section and polarization determinations. (M.O.W.)

27805 EXPERIMENTAL DATA ON INTERACTION OF COLLIDING BEAMS. Auslender, V. L.; Karliner, M. M.; Naumov, A. A.; Popov, S. G.; Skrinskii, A. N.; Tumaikin, G. M. At. Energ. (USSR), 20: 213-17(Mar. 1966). (In Russian).

The results of an experimental investigation of the interaction of electron and positron beams in storage rings are presented. (tr-auth)

27806 ELASTIC p-p SCATTERING AT 10 Gev/c. Barbetta, Maria Grazia; Baroni, Giustina; Depietri, Carlo; Manfredini, Augusta; Rossi, Valerio (Univ., Modena, Italy. Univ., Rome). Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur., 39: 77-82(July-Aug. 1965). (In Italian).

The differential cross section for elastic p-p scattering was measured on protons of 10 Bev/c using the nuclear emulsion technique. A target of polyethylene was used. The p-p reaction was obtained after subtraction of the measured evaporation separation from carbon. The values of a four-momentum transfer $3 \times 10^{-3} < t < 5 \times 10^{-2}$ (Bev/c)^2 are reported. From the analysis of the experimental data the ratio between the real and the imaginary parts of the nuclear scattering amplitude was calculated as $\rho = -0.30 \pm 0.05$. (tr-auth)

27807 DIRECT DETERMINATION OF THE SIGN AND THE VALUE OF THE GYROMAGNETIC RATIO OF THE PROTON. APPLICATION TO THE MEASUREMENT OF LOW ROTATION VELOCITIES. Benoit, Henri; Ribotta, Roland (Univ. Paris, Orsay, France). Compt. Rend., Ser. B., 262: 780-3(Mar. 14, 1966). (In French).

In a nuclear magnetic resonance experiment in a weak field and with liquid flow, transitions were induced by a transverse alternating rectilinear field whose direction turned around that of the static field. The displacement of the spectral lines produced by this rotation was shown. The magnitude and sign of this displacement made it possible to determine directly the magnitude and sign of the gyromagnetic ratio of the proton. (tr-auth)

27808 COMPARISON OF APPROXIMATION SCHEMES FOR CALCULATING PHASE-SPACE FACTORS IN THE 1 TO 10 Gev RANGE. Childers, R. L.; Galloway, K. F. (Univ. of South Carolina, Columbia). Nucl. Instrum. Methods, 41: 167-8(Apr. 1966).

A variety of approximation schemes is available for calculating phase-space factors for high-energy interactions, however, the different schemes give results of varying reliability. Several of these approximate methods for a three particle final state are considered. The process $\pi + N \rightarrow \pi + \pi + N$ is considered and the results compared with true values found by numerically integrating the appropriate expression. (B.G.D.)

27809 ANNIHILATION OF A NEUTRINO-ANTINEUTRINO PAIR INTO PHOTONS AND THE NEUTRINO DENSITY IN THE UNIVERSE. De Graaf, T.; Tolhoek, H. A. (Univ. of Groningen, Netherlands). Nucl. Phys., 81: 596-608(June 1966).

The cross section for the process $\nu_e + \bar{\nu}_e \rightarrow 3\gamma$ is calculated in the low-energy approximation, assuming a universal Fermi interaction. It is found that $\sigma \approx 9.5 \times 10^{-40} (\omega/m)^{10}$ cm^2 in the c.m. system of the $(\nu,\bar{\nu})$-pair ($\omega = E_\nu + E_{\bar{\nu}} < m$). If it is assumed that the universe contains degenerate Fermi gases of both neutrinos and antineutrinos, the above mentioned process provides the most important way for mutual annihilation of these gases. It results from our calculations that the rate of annihilation of neutrinos and antineutrinos is so small for any reasonable Fermi energy of the Fermi gases (smaller than, say, 100 ev), that both degenerate Fermi gases could coexist with negligible annihilation during a time of, e.g., 1.3×10^{10} y, typical for the present state of the universe. (auth)

27810 SOLUTION OF THE THREE-NUCLEON INTERACTION PROBLEM AT LOW AND MEDIUM ENERGIES. Popova, Anna M. (Moscow State Univ.). Nucl. Phys., 82: 209-21(1966).

The problem of the inelastic nucleon-deuteron interaction is solved in the case when two nucleons in the final state interact with a small relative momentum f. An expression for the amplitude of this reaction accurate to terms proportional to $(f/k_0)^2$, where k_0 is the momentum of the nucleons and deuterons in their c.m. system prior to the reaction, is obtained as the sum of the impulse approximation amplitude and a certain function which is the product of the amplitude for the interacting particles of relative momentum f and a quantity $C(k_0,\theta)$ depending on the initial energy and the scattering angle. Integral equations are obtained for determining the quantity $C(k_0,\theta)$. It is shown that the value of $C(k_0,\theta)$ for fixed values of the arguments can be determined from the experimental data. Analysis of the spectra of protons from the $n + d \rightarrow n + n + p$ reaction at 14 Mev neutron energy shows that the correction to the impulse approximation amplitude for small scattering angles amounts to no more than 30 to 40% of the imaginary part of the impulse approximation amplitude. (auth)

27811 GENERAL CHARACTERISTIC OF THE π^- PROTON INELASTIC COLLISIONS AT 10 Gev/c. Bartke, Jerzy (Inst. of Nuclear Research, Krakow). Nucl. Phys., 82: 673-9(1966).

Experimental data on the π^--proton interactions at 10 Bev/c are used for a discussion of two problems; i.e., the applicability of the statistical model and the existence of "central" collisions. First, it is shown that a simple version of the statistical model can be used in order to predict the relative probabilities for different reaction channels. Second, a method is proposed for the estimation of the fraction of central collisions. It is based on the symmetry of the angular distribution of baryons in the c.m. system and seems justified from the experimentalist's point of view. The cross section for central collisions evaluated according to this definition turns out to be 25–30% of the total inelastic cross section. This is consistent with the estimate of Fast and Hagedorn obtained from the analysis of the large-angle elastic scattering. (auth)

27812 DISPERSION RELATIONS AND KΛ PHOTOPRODUCTION ON A PROTON. Nelipa, N. F. (Lebedev Inst. of Physics, Moscow). Nucl. Phys., 82: 680-2(1966).

Experimental data on KΛ photoproduction on a proton are analyzed with the aid of the approximate set of integral equations for multipoles. The set of parameters is determined (including the KNΛ coupling constant).

27813 EVOLUTION OF A RESONANT STATE. Alzetta, R. (Univ., Trieste); d'Ambrogio, E. Nucl. Phys., 82: 683-9(1966).

The amplitude for the decay of an unstable system is exactly evaluated in the Lee model with form factor. Numerical estimates, which show the region of validity of the exponential law and the largetime deviations, are performed for the data of the $Y_{01}^* \rightarrow \Sigma^0 + \pi^0$ decay. (auth)

27814 PRODUCTION AND DECAY OF THE f^0 MESON. Cohn, H. O. (Oak Ridge National Lab., Tenn.); McCulloch, R. D.; Bugg, W. M.; Condo, G. T. Nucl. Phys., 82: 690-4 (1966). (ORNL-P-1686).

From the interaction of 3.29 Bev/c π^+ mesons with deuterium the production and decay of the f^0 meson was studied. The production is highly collimated in the forward direction. Under the assumption that the f^0 is a spin 2 meson, measurement of the decay angular distributions yields values for the f^0 spin density matrix elements. Only qualitative agreement with the one-pion exchange model is observed, the implication being that absorptive corrections and interference effects are required. (auth)

27815 NUCLEON POLARIZATION IN ELASTIC LEPTON OR ANTILEPTON PRODUCTION BY HIGH-ENERGY NEUTRINO OR ANTINEUTRINO. Fujii, A. (Sophia Univ., Tokyo); Yamaguchi, Y. Nuovo Cimento (10), 43A: 325-33(May 21, 1966).

The degrees of polarization of the final nucleon in the processes $\nu + n \rightarrow p + \mu^-$ and $\bar{\nu} + p \rightarrow n + \mu^+$ are calculated for an unpolarized target nucleon. Three models for this elementary interaction are considered as numerical examples. The degrees of polarization, two transverse and one longitudinal, turn out to be crucial observables to distinguish these models. (auth)

27816 TRANSVERSE-MOMENTUM DISTRIBUTION, MANDELSTAM REPRESENTATION AND OPTICAL POTENTIAL FOR p-p SCATTERING. Chavda, L. K.; Narayan, D. S. (Tata Inst. of Fundamental Research, Bombay). Nuovo Cimento (10), 43A: 382-96(May 21, 1966).

The experimental angular distribution of particles in p-p scattering seems to depend essentially on a single variable $p_t = q \sin\theta$ instead of depending separately on the momentum q and the angle of scattering θ. For small values of p_t, the angular distribution can be represented as a Gaussian in p_t as exp $[-ap_t^2]$ and for large values of p_t, as an exponential in p_t as exp $[-bp_t]$. Using this empirical information a scattering amplitude which has the Mandelstam singularity structure and which leads at the same time to the empirically observed transverse momentum dependence for small and large p_t is constructed. The relevant spectral functions are calculated and the scattering amplitude expressed as the usual integrals over the spectral functions. It is shown that for spinless identical particles, the ratio of the real part to the imaginary part of the scattering amplitude in the forward direction goes to zero at high energies and that this ratio in nonforward directions is smaller than that in the forward direction. From the scattering amplitude suggested an optical potential is derived which would give approximately the observed p-p scattering. (auth)

27817 HIGH-ENERGY LARGE-ANGLE SCATTERING AND FORCES AT SMALL DISTANCES. Cottingham, W. N.; Dombey, N. (Rutherford High-Energy Lab., Chilton, Eng.). Nuovo Cimento (10), 43A: 397-412(May 21, 1966).

Complex potential models of proton-proton high-energy large-angle scattering are investigated. It is found that there are two essentially different kinds of potential which generate exponentially small scattering amplitudes. The potentials must be very singular at the origin or else bounded and also smooth. Experimental tests to distinguish between them are proposed. (auth)

27818 PARTICLE MIXING AND THE BREAKING OF CHARGE SYMMETRY IN THE Λ-N INTERACTION. Downs, B. W. (Univ. of Colorado, Boulder). Nuovo Cimento (10), 43A: 454-67(May 21, 1966).

Electromagnetic mixing of isotopic-spin eigenstates leads to important charge-symmetry-breaking (CSB) elements in the Λ-N interaction. The most important mixing is that for Σ^0-Λ, which allows coupling of the (dominant) T = 1 component of physical π^0 and ρ^0 to the physical Λ. π^0-η and ρ^0-ω-φ mixing give additional contributions. A single-meson-exchange CSB potential model is constructed from these mixings, with the help of the octet model of SU_3 to relate meson-baryon couplings. The difference between Λ bindings in the mirror hypernuclei $^4He_\Lambda$ and $^4H_\Lambda$ may be explained with this model, in which vector-meson exchange is more important than pseudoscalar-meson exchange. Predictions of the model for Λ-N scattering and for binding energies of possible excited states of the four-body hypernuclei are given. (auth)

27819 EQUIVALENT-POTENTIAL APPROACH TO STRONG INTERACTIONS: VARIATIONAL METHOD. DerSarkissian, M. (Univ. of Alberta, Edmonton); Kamal, A. N. Nuovo Cimento (10), 43A: 468-74(May 21, 1966).

A variational calculation for p-wave π-π scattering using the equivalent-potential approach originally suggested by Balázs is presented. The trial wave function inside the potential, chosen as $u_1(r,\alpha) \simeq r^2 e^{-\alpha r}$, is varied with the help of the variational parameter α till a value of α is found which not only produces a resonance at the self-consistent mass of the ρ-meson but is also the "best" variational parameter, i.e., $(q^3/\sqrt{s})$ ctgδ has a minimum at this energy. As a consequence a self-consistent ρ-meson with $\Gamma = 0.48$, $m = 4.4$ and $\alpha = 5.12$ is found. (auth)

27820 EFFECT OF THE TWO-NUCLEON POTENTIAL SHAPE ON THE NEUTRON-DEUTERON SCATTERING LENGTHS. Sitenko, A. G.; Kharchenko, V. F.; Petrov, N. M. (Inst. of Physics, Kiev). Phys. Lett., 21: 54-7 (Apr. 15, 1966).

The effect of the shape of the two-nucleon interaction on values of the quartet and doublet neutron-deuteron scattering lengths are studied. Various nonlocal interactions, including a tensor one, are employed in the calculation. (B.G.D.)

27821 RESONANCES IN THE S_{11} PION-NUCLEON AMPLITUDE. Michael, C. (Oxford Univ.). Phys. Lett., 21: 93-5(Apr. 15, 1966).

The S_{11} πN phase shift is interpreted as the sum of an inelastic resonance at 1570 Mev and an elastic one at 1700 Mev using a general formulation for combining such contributions. (auth)

27822 CONSISTENCY OF PION-PION PHASE SHIFTS WITH ANALYTICITY. Lukaszuk, L.; Martin, A. (CERN, Geneva). Phys. Lett., 21: 96-7(Apr. 15, 1966).

Rigorous inequalities on the pion-pion D wave scattering lengths are derived. They are shown to be important constraints in the analysis of experimental data. (auth)

27823 CURRENT ALGEBRAS AND ANNIHILATIONS INTO TWO MESONS. Gervais, J. L. (Univ. Paris, Orsay, France).; Iliopoulos, J.; Kaplan, J. M. Phys. Lett., 21: 103-6(Apr. 15, 1966).

Using current algebras in the low-energy limit, relations between electron-positron annihilations into two pseudoscalar mesons and meson-meson scattering are derived. Some relations for proton-antiproton annihilations at rest are also obtained. (auth)

27824 HYPERON-NUCLEON INTERACTION AND THE F/(F + D) RATIO. Helder, J. C.; De Swart, J. J. (Univ., Nijmegen, Netherlands). Phys. Lett., 21: 109-11(Apr. 15, 1966).

The low energy Σ^-p interactions are considered, using a potential model. A good fit with the experimental data is obtained for the SU(6) prediction, $F/(F + D) \approx 0.4$. A sizable polarization in the reaction $\Sigma^-p \rightarrow \Lambda n$ at these low energies is predicted. (auth)

27825 PRODUCTION OF A_1, A_2, AND B MESONS IN HIGH-ENERGY $\pi^\pm$p INTERACTIONS. Ferbel, T. (Univ. of Rochester, N. Y.). Phys. Lett., 21: 111-13(Apr. 15, 1966).

Data on multiple meson production in pion-proton collisions were compiled in an attempt to observe the direct production of A_1, A_2, and B mesons without imposing selection criteria of any kind on the data. (auth)

27826 MEASUREMENT OF THE POLARIZATION PARAMETERS IN π^-p ELASTIC SCATTERING AT 6.0, 8.0, AND 10.0 Gev/c. Borghini, M.; Coignet, G.; Dick, L.; Di Lella, L.; Michalowicz, A.; Macq, P. C.; Olivier, J. C. (CERN, Geneva). Phys. Lett., 21: 114-17(Apr. 15, 1966).

The polarization parameter P_0 in π^-p elastic scattering at 6.0, 8.0, and 10.0 Bev/c was measured in the interval of invariant four-momentum transfers t from −0.1 to −0.75 $(Bev/c)^2$, using a target containing polarized protons. (auth)

27827 K^- +p ELASTIC SCATTERING AT 3.46 Gev/c. Gordon, J. (Univ. of Glasgow). Phys. Lett., 21: 117-20 (Apr. 15, 1966).

1691 events were fitted to K^-p elastic scatters at a K^- momentum of 3.46 Bev/c. The differential cross section as a function of 4 momentum transfer was fitted to exp $(A + Bt + Ct^2)$ with A = 3.7 B = 8.7 $(Bev/c)^{-2}$ and C = 2.0 $(Bev/c)^{-4}$. The distribution is consistent with zero real part for the forward scattering amplitude. (auth)

27828 ON THE $|\Delta I| = \frac{1}{2}$ RULE IN KAON DECAYS. D'espagnat, B.; Iliopoulos, J. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Phys. Lett., 21: 232-4(May 1, 1966).

A recent derivation of the $|\Delta I| = \frac{1}{2}$ rule for the non-leptonic K-decay amplitudes is examined. Some doubts are raised concerning the applicability of the result to the physical situation. (auth)

27829 POLARIZATION IN THE ELASTIC SCATTERING OF 50-Mev PROTONS BY DEUTERONS AT BACKWARD ANGLES. Johnston, A. R. (Queen's Univ., Belfast); Gibson, W. R.; McClatchie, E. A.; Megaw, J. H. P. C.; Griffiths, R. J. Phys. Lett., 21: 309-11(May 15, 1966).

The polarization in p(d,d)p scattering of 50 Mev protons was measured in the angular range 120 to 175° cm. The polarization changes rapidly to positive values at 135° and has a maximum of +0.185 ± 0.015 at 145°. (auth)

27830 ONE-BOSON-EXCHANGE MODELS AND THE NUCLEON-NUCLEON PROBLEM. Arndt, R. A.; Bryan, R. A.; MacGregor, M. H. (Univ. of California, Livermore). Phys. Lett., 21: 314-18(May 15, 1966). (UCRL-14687-T).

The four-pole boson exchange model is fit to nucleon-nucleon data, using a matrix representation for the data. The coupling parameters thus obtained do not depend markedly on unitarity corrections applied to the model. (auth)

27831 DYNAMICAL DERIVATION OF A RESULT RECENTLY OBTAINED FROM SYMMETRIES. Lyth, D. H. (Univ. of Birmingham, Eng.). Phys. Lett., 21: 338-9 (May 15, 1966).

The value of an integral over the P_{33} πN amplitude (which has recently been obtained from symmetry arguments) is obtained from dispersion theory and compared with experiment. It is emphasized that the value of the integral is determined theoretically much better than is the P_{33} amplitude itself. (auth)

27832 REGGE POLE DOMINANCE AT HIGH ENERGIES; AN EXPERIMENTAL TEST. Abers, E. (Univ. of California, Los Angeles); Burkhardt, H.; Teplitz, V.; Wilkin, C. Phys. Lett., 21: 339-42(May 15, 1966).

The energy dependence of the shadow effect in the scattering of high energy particles from deuterons is shown to provide a sensitive check of the dominance of moving singularities in the angular momentum plane in the high energy scattering from protons and neutrons. Regge theory predicts that the shadowing should decrease as an inverse power of the energy. (auth)

27833 POSITRON MOMENTUM SPECTRUM AND BRANCHING RATIO OF K^+_{e3}. Cester, R. (Princeton Univ., N. J.); Eschstruth, P. T.; O'Neill, G. K.; Quassiati, B.; Yount, D.; Dobbs, J. M.; Mann, A. K.; McFarlane, W. K.; White, D. H. Phys. Lett., 21: 343-7(May 15, 1966). (PPAD-578-E).

The momentum spectrum of positrons from $K^+ \rightarrow \pi^0 + e^+ + \nu$ was measured. The observed spectrum, containing 1679 events, is consistent with vector coupling with upper limits of 18 and 4 percent of scalar and tensor admixtures, respectively. The K^+_{e3} branching ratio was measured to be 0.0498 ± 0.002. (auth)

27834 OBSERVATION OF X^0 PRODUCTION IN π^+n INTERACTIONS. Cohn, H. O. (Oak Ridge National Lab., Tenn.); McCulloch, R. D.; Bugg, W. M.; Condo, G. T. Phys. Lett., 21: 347-9(May 15, 1966). (ORNL-P 2113).

The production of the X^0 in the $\pi^+ + d$ interaction at 3.29 Bev/c, uncorrelated with N* formation was observed. The X^0 was found in both the $\pi^+\pi^-$ MM and the $\pi^+\pi^-\pi^+\pi^-\pi^0$ systems. (auth)

27835 K^--PROTON CHARGE EXCHANGE INTERACTIONS AT LOW ENERGIES AND SCATTERING LENGTHS DETERMINATION. Kittel, W.; Otter, G.; Wacek, I. (Univ., Vienna). Phys. Lett., 21: 349-51(May 15, 1966).

Low energy K^-p charge exchange interactions were studied in the hydrogen bubble chamber. Angular distribution in cm was fitted for S and S plus P waves. In combination with other cross sections the scattering lengths were determined in the zero range approximation. (auth)

27836 CORRELATIONS BETWEEN LONGITUDINAL AND TRANSVERSE MOMENTA OF SECONDARIES IN HIGH-ENERGY INTERACTIONS. Bardadin-Otwinowska, M.; Michejda, L.; Otwinowski, S.; Sosnowski, R. (Univ. of Warsaw. Inst. for Nuclear Research, Warsaw). Phys. Lett., 21: 351-3(May 15, 1966).

A correlation between the average transverse momentum and the cms longitudinal momentum of secondary pions and protons was observed in the 10 Bev/c π^--p interaction. Similar correlation is predicted by the invariant phase space calculation. (auth)

27837 REACTION $\pi^-p \rightarrow \omega N^{*0}$ AT 2.75 Gev/c. Alitti, J. (CEN, Saclay, France); Baton, J. P.; Fickinger, W.; Neveu-Rene, M.; Romano, A.; Gessaroli, R. Phys. Lett., 21: 354-7(May 15, 1966).

At 2.75 Bev/c, the reaction $\pi^-p \rightarrow \pi^-p\pi^-\pi^+\pi^0$ is dominated by the quasi-two-body final states ωN^{*0}_{33} (1236 Mev) and ωN^{*0}_{13} (1518 Mev). There is no production of the B^- enhancement. The spin space density matrix elements for the ωN^{*0}_{33} final state are compared with those for other reactions. (auth)

27838 EVIDENCE FOR THE PRODUCTION OF N*(2830) IN π^+-p INTERACTIONS AT 8 Gev/c. Bardadin-Otwinowska, M.; Danysz, M.; Hofmokl, T.; Otwinowski, S.; Piotrowska, H.; Sosnowski, R.; Szeptycka, M.; Wroblewski, A. (Warsaw Univ. Inst. of Nuclear Research, Warsaw). Phys. Lett., 21: 357-8(May 15, 1966).

The energy dependence of cross section for the reaction $\pi^+ + p \rightarrow p + \pi^+ + \pi^+ + \pi^-$ suggests that the $T \geq \frac{3}{2}N^*(2830)$ isobar can decay into $p\pi^+\pi^+\pi^-$. This conjecture is confirmed by the appearance of 2.8–2.9 Bev peak in the $p\pi^+\pi^+\pi^-$ invariant mass distribution from the reaction $\pi^+ + p \rightarrow p\pi^+\pi^+\pi^+\pi^-\pi^-\pi^0$ studied at 8 Bev/c π^+ momentum. (auth)

27839 SU(3) SYMMETRY AND MESON PHOTOPRODUCTION ON THE PROTON. Nelipa, N. F. (Lebedev Inst. of Physics, Moscow). Phys. Lett., 21: 359(May 15, 1966).

A SU(3) symmetry prediction for the photoproduction of mesons is tested. Theory and experiment are in disagreement. (auth)

27840 NON-APPEARANCE OF CHARGE-$\frac{2}{3}$ QUARKS AT GREAT DEPTHS UNDERGROUND. Barton, J. C.; Stockel, C. T. (Northern Polytechnic, London). Phys. Lett., 21: 360(May 15, 1966).

At a depth of 2200 hg cm^{-2} of rock the intensity of particles of charge $\frac{2}{3}$ was found to be not greater than 0.005 m^{-2} str^{-1} hr^{-1}. (auth)

27841 TIME-LIKE MOMENTA IN QUANTUM ELECTRODYNAMICS. Brodsky, Stanley J.; Ting, Samuel C. C. (Columbia Univ., New York). Phys. Rev., 145: 1018-22 (May 27, 1966). (NYO-1932-103).

Electron pair production by high-energy muons in a Coulomb potential was considered as a test of quantum electrodynamics in the time-like regions. If triple coincidence configurations are selected whereby the total momentum of the three final leptons is in the incident muon direction and the electron-positron pair is detected symmetrically with respect to the muon scattering plane, then the differential cross section is obtained in a simple analytical form. With these constraints it is seen that for a given effective mass of the pair, the contributions to the cross section involving time-like photon propagators become dominant as the muon scattering angle increases, although the cross section decreases slowly. If the con-

straints are relaxed, the cross section increases by orders of magnitude but the above features of the cross section persist. Thus, for a 10-Bev/c incident muon, nuclear charge Z = 10, and effective pair mass 100 Mev, the cross section is nominally 10^{-32} cm^2/(Mev)^2(sr)^3, the time-like contribution gives more than 80% of the cross section, and the momentum transfer to the nucleus is less than 50 Mev/c over ranges of polar angles $\Delta\theta$ = 20 mrad, azimuthal angles $\Delta\phi$ = 40° and momenta ΔP = 1 Bev/c. The characteristic behavior of the cross section is presented in graphical form and a simple method of computing the differential cross section (without involving large cancellations of gauge-variant quantities) is discussed. (auth)

27842 DECAY PROPERTIES OF THE ω MESON. Flatte, Stanley M.; Huwe, Darrell O.; Murray, Joseph J.; Button-Shafer, Janice; Solmitz, Frank T.; Stevenson, M. Lynn; Wohl, Charles (Univ. of California, Berkeley). Phys. Rev., 145: 1050-61(May 27, 1966). (UCRL-16443).

The reaction $K^-p \rightarrow \Lambda\omega$, as observed in the hydrogen bubble chamber, has provided over 4600 examples of ω decay. The distribution of pion momenta in the decay $\omega \rightarrow \pi^+\pi^-\pi^0$, of which 4200 examples were seen, is found to be consistent with C conservation. With the assumption that the ω spin is 1^-, the pion-momentum distributions predicted by two different decay matrix elements are compared with the experimental distributions, as a test for final-state interactions. It is also shown that a spin of 3^- for the ω is unlikely. Branching fractions of other decay modes with respect to the $\pi^+\pi^-\pi^0$ decay mode are: neutrals, 0.097 ± 0.016; ηγ, <0.017; $\eta\pi^0$, <0.017; $\pi^+\pi^-\gamma$, <0.05; e^+e^-, <0.0003; and $\mu^+\mu^-$, <0.0017. The $\omega \rightarrow \pi^+\pi^-$ branching fraction lies between $(0.17 \pm 0.03)^2 = 0.029$ (coherence between the ρ and the ω production amplitudes assumed) and 0.082 ± 0.020 (incoherence assumed). (auth)

27843 REACTION $K^-p \rightarrow \Lambda\omega$: 1.2 TO 1.8 Bev/c. Eberhard, Philippe; Flatte, Stanley M.; Huwe, Darrell O.; Button-Shafer, Janice; Solmitz, Frank T.; Stevenson, M. Lynn (Univ. of California, Berkeley). Phys. Rev., 145: 1062-72(May 27, 1966). (UCRL-11982).

Both total and differential cross sections for the reaction $K^-p \rightarrow \Lambda\omega$ were determined within the following region of s, the total cms energy squared, and t, the four-momentum-transfer squared: $(1.88 \text{ Bev})^2 < s < (2.09 \text{ Bev})^2$ and $-(1.28 \text{ Bev})^2 < t < -(0.29 \text{ Bev})^2$. The decay angular correlations of the Λ decay products ($p\pi^-$) and the ω decay products ($\pi^+\pi^-\pi^0$) were systematically determined. In three subregions of s and t, the six production amplitudes that describe the reaction were determined. It is shown that no simple exchange models explain the data and that no striking resonance formation in the direct channel is taking place. (auth)

27844 NONSTRANGE-RESONANCE PRODUCTION IN π^+p COLLISIONS AT 2.35, 2.62, AND 2.90 Bev/c. Alff-Steinberger, C. (Columbia Univ., New York); Berley, D.; Colley, D.; (and others). Phys. Rev., 145: 1072-94 (May 27, 1966).

In an exposure of the 20-in. hydrogen bubble chamber to a separated π^+ beam at π^+ momenta of 2.35 Bev/c (center-of-mass energy $E^* = 2.30$ Bev), 2.62 Bev/c ($E^* = 2.41$ Bev), and 2.90 Bev/c ($E^* = 2.52$ Bev), production of the ω^0, ρ^0, and η^0 mesons was observed. The production of the ω^0, ρ^0, and η^0 is often accompanied by simultaneous production of the N^{*++}. The momentum transfer in ω^0 and ρ^0 production is characteristic of peripheral collisions and suggests a single-particle exchange for the production mechanism. The decay distributions for the ω^0, ρ^0, and the ρ^+ demonstrate the importance of modifying the single-particle-exchange model to include absorptive effects. An upper limit on the two-π decay of the ω^0 is set at 2%. The width of the η^0 is found to be less than 10 Mev. Elastic-scattering distributions are presented. (auth)

27845 ANNIHILATIONS OF ANTIPROTONS AT REST IN HYDROGEN. IV. $\bar{p}p \rightarrow \overline{K}K\pi\pi$. Barash, N.; Kirsch, L.; Miller, D.; Tan, T. H. (Columbia Univ., New York). Phys. Rev., 145: 1095-1102(May 27, 1966). (CU-1932-249; R-534; NEVIS-143; CU-249).

In a study of 735,000 antiproton annihilations at rest in the hydrogen bubble chamber, 3424 events of the reaction $\bar{p} + p \rightarrow K\overline{K}\pi\pi$ were observed. The invariant-mass distributions and scatterplots for this reaction, separated according to the three channels $K_1K_1\pi^+\pi^-$, $K_1(K^0)\pi^+\pi^-$, and $K_1K^\pm\pi^\mp\pi^0$ are presented. Also presented are branching ratios into the various channels. K* production is found to dominate in all cases. The fraction of $\bar{p}p$ annihilations into $K^*\overline{K}^*$ is $(4.5 \pm 0.9) \times 10^{-3}$, and into $K^*K\pi$ is $(7.7 \pm 1.7) \times 10^{-3}$. (auth)

27846 ANNIHILATIONS OF ANTIPROTONS AT REST IN HYDROGEN. V. MULTIPION ANNIHILATIONS. Baltay, C.; Franzini, P.; Luetjens, G.; Severiens, J. C.; Tycko, D.; Zanello, D. (Columbia Univ., New York). Phys. Rev., 145: 1103-11(May 27, 1966). (CU-1932-248; NEVIS-142; R-532; CU-248).

Approximately 45,000 pionic annihilations of stopped antiprotons in hydrogen were measured and analyzed. The relative annihilation rates into the various multipion final states are presented. The experimental distributions of the invariant masses of all the possible pion combinations were obtained. Strong production of the ρ, ω, and η meson was observed, and their production rates were established. The rates for simultaneous production of $\rho^0\rho^0$, $\rho^0\omega^0$, and $\rho^0\eta^0$ are discussed. (auth)

27847 PHOTOPRODUCTION AND ELECTROPRODUCTION OF PIONS IN THE REGION OF THE N*(1238). Zagury, N. (Univ. of California, San Diego, La Jolla). Phys. Rev., 145: 1112-7(May 27, 1966).

The photoproduction and electroproduction of pions is treated relativistically. A new solution for the 3-3 amplitudes is obtained which includes recoil and is insensitive to a cutoff. Corrections to the E_{0+} and M_{1-} amplitudes are evaluated by using fixed-t dispersion relations. Good results are obtained in the region around the 3-3 resonance up to π-N center-of-mass energies about 1300 Mev and electron momentum transfer up to 3.8 Bev^2. (auth)

27848 $\pi^- + p \rightarrow \pi + \pi +$ NUCLEON REACTIONS. Hagopian, V. (Univ. of Pennsylvania, Philadelphia); Selove, W.; Alitti, J.; Baton, J. P.; Neveu-Rene, M. Phys. Rev., 145: 1128-35(May 27, 1966).

Data from two π^- + proton experiments, at 2.75 and 3.0 Bev/c were compared and combined. Some 3400 events of the final-state $\pi^-\pi^+$ neutron and 2000 of the $\pi^-\pi^0$ proton were found. These events are dominated by the ρ resonance. The decay angular distribution of the ρ^- agrees suprisingly well with the one-pion-exchange theory modified for absorption effects, as calculated by Gottfried and Jackson. The ρ-production angular distributions exhibit a difference between ρ^- and ρ^0 at Δ^2 values (4-momentum transfer to nucleon, squared) of 20 to 40 M_π^2. ρ^0 production shows a weak backward peak. The ρ^0 mass region shows effects interpretable as due to the 720-Mev T = 0 s-wave ππ resonance, and to $\omega^0 \rightarrow \pi^+\pi^-$ decay. Analysis of the data in terms of ππ scattering is discussed. A simple phase-shift analysis using "physical-region" single-pion production data directly, without extrapolation to the one-pion pole, will not in general be valid for Δ^2 greater than 2 or 3 M_π^2; insufficient information exists to determine whether data of lower Δ^2 values can be meaningfully used without extrapolation. S-wave ππ scattering in the mass region below the ρ is discussed. The ABC and σ effects do not show up in these data. (auth)

27849 ELASTIC K^--PROTON INTERACTION AT 1.45 Gev/c AND COMPARISON WITH ABSORPTION MODELS. Fridman, A. (Centre de Recherches Nucleaires, Strasbourg. Univ., Heidelberg); Benary, O.; Michalon, A.; Schiby, B.; Strub, R.; Zech, G. Phys. Rev., 145: 1136-9 (May 27, 1966).

The K^--p scattering at 1.45 Bev/c was studied. A comparison with absorption models for low scattering angle was made. The presence of a backward bump in the elastic differential cross section seems to indicate a spin-flip part in the scattering amplitude. The comparison with other data suggests a possible trend for a shrinking of the diffraction peak in the K^--p scattering. (auth)

27850 DETERMINATION OF THE NUCLEON'S ISOTOPIC SPECTRAL FUNCTIONS. Orman, Bryan A. (Univ. of Alberta, Edmonton). Phys. Rev., 145: 1140-5 (May 27, 1966).

The method of exact inversion, discussed previously is employed to determine the nucleon's isotopic spectral functions from their corresponding real form factors. Specific analytic expressions, as suggested by previous pole fits, are used for the real form factors and these give spectral functions that have all the required analytic properties. The constraint that the electric and magnetic form factors are equal at the threshold for proton-antiproton annihilation into an electron-positron pair is used throughout. It is found that the complex proton's form factors are zero at the annihilation threshold and using this observation the results are compared with the predictions of the internal symmetry theories. (auth)

27851 TENTH $J^P = 2^+$ MESON AS A DYNAMICAL CONSEQUENCE OF $\overline{SW}(3)$ SYMMETRY. Munczek, Herman; Pignotti, Alberto; Virasoro, Miguel Angel (Facultad de Ciencias Exactas y Naturales, Buenos Aires). Phys. Rev., 145: 1154-6(May 27, 1966).

The generalization of the meson bootstrap scheme to $\overline{SW}(3)$ symmetry is considered. Assigning the spin zero mesons to the $(3,3^*)\oplus(3^*,3)$ representation it is found that the leading Regge trajectory is an $\overline{SW}(3)$ singlet and it is identified with the Pomeranchuk trajectory. In addition it is observed that the self-consistent solution includes the vector and axial vector mesons in the $(1,8)\oplus(8,1)$ and the spin 2 mesons in the $(3,3^*)\oplus(3^*,3)$ representation. Thus the existence of a tenth $J^P = 2^+$ meson is predicted. It is suggested that the missing meson is the Pomeranchuk particle and that it should be found at an energy considerably smaller than the 2^+ nonet mass. (auth)

27852 MAGNETIC MOMENT OF THE $\frac{3}{2}^+$ DECUPLET FROM THE ALGEBRA OF CURRENT COMPONENTS. Rajaraman, R. (Univ. of Southern California, Los Angeles). Phys. Rev., 145: 1164-5(May 27, 1966). (USC-136-107).

The magnetic moments of the $\frac{3}{2}^+$ baryon resonances are calculated using the algebra of current components. The commutators are evaluated between $\frac{3}{2}^+$ states at rest, and all allowed particles and resonances at rest as used as intermediate states, including the $\frac{5}{2}^+$ octet observed recently. Relations are derived between the static magnetic moments and the charge distributions of the $\frac{3}{2}^+$ states, which are specially meaningful for the long-lived Ω^-. It is found that the results do not agree with the static SU(6) predictions. (auth)

27853 RADIATIVE PIONIC DECAYS OF $\Sigma^\pm$ HYPERONS. Young, Robert D.; Sugawara, Masao; Sakuma, Tetsuro (Purdue Univ., Lafayette, Ind.). Phys. Rev., 145: 1181-4 (May 27, 1966).

The radiative decays $\Sigma^\pm \to n + \pi^\pm + \gamma$ are analyzed on the assumption that the pole approximation is valid for the decays $\Sigma^\pm \to n + \pi^\pm$. It is shown that the matrix elements for these radiative decays are essentially the same as those for the phenomenological inner-bremsstrahlung diagrams as long as the anomalous magnetic moments of the Σ and Λ hyperons are at most of the order of magnitude of the nucleon magnetic moments. This is true independently of the signs and magnitudes of the strong and weak vertices involved. The branching ratios of $\Sigma^\pm \to n + \pi^\pm + \gamma$ to $\Sigma^\pm \to n + \pi^\pm$ depend on whether the pion in $\Sigma^\pm \to n + \pi^\pm$ is in the S- or the P-wave state, in general agreement with what was pointed out previously. However, in contrast with the results of the previous calculation, the analysis shows that the anomalous magnetic moments of $\Sigma^\pm$ and the neutron noticeably contribute to the branching ratios. Therefore, in order to check the underlying theoretical assumptions so as to determine the pion-wave assignment in $\Sigma^\pm \to n + \pi^\pm$, it is necessary to have either very accurate data for $\Sigma^\pm \to n + \pi^\pm + \gamma$ or an experimental determination of the anomalous magnetic moments of $\Sigma^\pm$. (auth)

27854 EQUIVALENT-POTENTIAL CALCULATION OF $\pi\pi$ AND πK SCATTERING. Finkelstein, Jerome (Univ. of California, Berkeley). Phys. Rev., 145: 1185-8(May 27, 1966). (UCRL-16537).

A method suggested by Balázs is used to calculate the $\pi\pi$ and πK amplitudes in the resonance region. An input force corresponding to vector-meson exchange reproduces the vector mesons, and also produces 2^+ mesons at roughly the masses of the $f^0(1250)$, $f'^0(1500)$, and $K^{**}(1405)$. Inclusion of an estimate of Pomeranchuk exchange in the input improves the output slightly. Regge trajectories and residues are computed, and their intercepts agree approximately with estimates based on high-energy experiments. (auth)

27855 ANALYSIS OF THE KN SCATTERING BY THE EXACT N/D METHOD. Agarwal, S. C. (National Physical Lab., New Delhi). Phys. Rev., 145: 1196-1205 (May 27, 1966).

The KN-scattering phase shifts are calculated by considering the forces due to one-particle exchange, and using the exact N/D method. The particles exchanged are Λ, Σ, Y_1^* and Y_0^* in the u channel and ρ and ω in the t channel. The coupling constants are taken from SU(3) symmetry and experiments. Two parameters are used for fitting the experimental data: the D-F mixing parameter f and the cutoff parameter W_c. Two sets of phase shifts exist in the case of the I = 0 state for p and higher partial waves due to the Fermi-Yang ambiguity. It is found that the values of the parameters which give a good fit in the case of s-wave I = 0 and I = 1 phase-shift data (which are unique) lead to a set of phase shifts which favors the Yang set. (auth)

27856 PROTON-PROTON BREMSSTRAHLUNG. Ueda, Yoshiaki (Indiana Univ., Bloomington). Phys. Rev., 145: 1214-28(May 27, 1966).

Proton-proton bremsstrahlung is investigated by using a field-theory, as opposed to a potential, model. The one-pion-exchange model is adopted, and part of the matrix element is related to the photon-pion production matrix element, which is expressed in terms of dispersion relations. A detailed analysis shows that the Born-approximation diagrams give the dominant contribution and that the diagrams involving N^* or ρ resonances are negligible for the energy considered. The results, unlike those of the potential model, seem to give satisfactory agreement with experimental data. (auth)

27857 ISOBAR MODEL FOR RESONANCE SCATTERING. Brudnoy, David M. (Univ. of Minnesota, Minneapolis). Contract AT(11-1)-1371.Phys. Rev., 145: 1229-35(May 27, 1966).

An explicit representation of the Rarita-Schwinger wave function is constructed, and with its help it is shown that many calculations of resonance scattering within an isobar model can easily be performed without explicitly calculating the propagator function. (auth)

27858 DYNAMICS OF THE $N^*(\frac{5}{2}^-)$. Auvil, P. R.; Brehm, J. J. (Northwestern Univ., Evanston, Ill.). Phys. Rev., 145: 1243-7(May 27, 1966).

A dynamical model of the D_{15} pion-nucleon resonance is considered. Since the branching ratio for decay into the πN channel is less than $\frac{1}{2}$, first the case in which the resonance is produced in πN^* scattering is treated. The coupling to the ρN^* inelastic channel is assumed to dominate the forces, and the N/D equations, solved in a pole approximation, are employed. The generalization of this model to SU(3) symmetry is considered, and a resonant octet obtained. Finally the three-channel problem with the πN channel included is treated. The calculated mass and branching ratio of the resonance are in good agreement with experiment but the total width is too small. (auth)

27859 ELECTROMAGNETIC INTERACTION IN STATIC STRONG-COUPLING THEORY. Bose, S. K. (Univ. of Delhi). Phys. Rev., 145: 1247-50(May 27, 1966).

Electromagnetic properties of isobars are studied using the group-theoretic formulation of the strong-coupling theory due to Cook, Goebel, and Sakita. Expressions for magnetic moment and electromagnetic mass shifts for isobars

are obtained in the scalar and the pseudoscalar theories. The significance of these results is briefly discussed. (auth)

27860 CONNECTION BETWEEN REGGE POLES AND ELEMENTARY PARTICLE POLES. Saito, Takesi (Univ. of California, Berkeley). Phys. Rev., 145: 1302-6(May 27, 1966). (UCRL-16544).

It is shown that if in a field theory the proper vertex function $\Gamma(s)$ vanishes under a condition that the proper vertex-function poles are not the poles of scattering amplitudes, then the elementary particle lies smoothly on the Regge trajectory. [The condition $\Gamma(s) \equiv 0$ does not always mean the vanishing of the coupling constant, when the vertex function poles exist.] The bootstrap equations are immediate consequences of the above condition. The problem is formulated using multichannel theory. Other related results are: It is found that in the multichannel case as well as in the single-channel case, the proper vertex poles are not the poles of scattering amplitudes if the poles come up from the second Riemann sheet. The finite self-mass condition of the composite particle, due to Gerstein and Deshpande, is not applicable when the proper vertex pole appears below the elementary-particle mass, i.e., the modified propagator needs one subtraction. Vanishing renormalization constants, $Z_1 = Z_3 = 0$, are not sufficient to Reggeize the elementary particle. All conclusions remain true even when additional bound-state poles are included. In the latter case, however, a different condition, due to Kaus and Zachariasen, that the form factor (improper vertex function) and Z_3 both vanish is also used; then the main results again follow, that the elementary particle lies on the Regge trajectory and that the bootstrap equations are obtained. (The vanishing form factor does not always mean the vanishing of the coupling constant, when the bound-state poles exist.) But this last condition implies that the unsubtracted dispersion relations in weak interactions are not valid. (auth)

27861 ANALYSIS OF SINGLE-PION PRODUCTION REACTIONS $\pi + N \rightarrow \pi_1 + \pi_2 + N'$ BELOW 1 Bev. Olsson, M. G. (Univ. of Wisconsin, Madison); Yodh, G. B. Phys. Rev., 145: 1309-26(May 27, 1966).

A phenomenological investigation of the low-energy pion production process was carried out using an amplitude for s-wave N* production as well as a totally isotropic amplitude. It is found that these two amplitudes in $T = \frac{3}{2}$ and $T = \frac{1}{2}$ isotopic-spin channels will give a reasonable explanation of most of the experimental data below 700 Mev. A detailed comparison with experimental data in five single-pion production reactions is carried out to determine the seven model parameters. The analysis shows that the $T = \frac{3}{2}$ reactions are explained by constant amplitudes and phases in the P_{31} and D_{33} states; that the D_{13} inelastic phase must rise through 90° near 600 Mev; and that there must be a significant P_{11} amplitude. The model does not account for the peaking of the $\pi^+\pi^-$ mass at the upper end of the phase space. Possible causes of this $T = 0$, $\pi\pi$ enhancement are discussed. (auth)

27862 PARTIAL-WAVE ANALYSIS OF THE REACTIONS $\pi^+ + p \rightarrow \pi^+ + \pi^0 + p$ AND $\pi^+ + \pi^+ + n$ BELOW 1 Bev. Yodh, G. B. (Univ. of Maryland, College Park); Olsson, M. Phys. Rev., 145: 1327-31(May 27, 1966).

A partial-wave analysis of the reaction $\pi^+p \rightarrow \pi^+\pi^0p$ and $\pi^+p \rightarrow \pi^+\pi^+n$ is carried out in the energy region from 400 to 800 Mev for the incident-pion kinetic energy. In the analysis, single-pion production is described in terms of an extended isobar model. It is shown that partial waves leading to p- and d-wave production of the N*(3,3) isobar cannot be the dominant states. Using the $P_{\frac{1}{2}}$ state leading to p-wave isobar production as the important background state in $\pi^+\pi^0p$ channel, it is possible to account for the observed angular distributions at 600 and 820 Mev. The same parameters also give a good fit to the $\pi^+\pi^+n$ angular distributions at 600 Mev. (auth)

27863 VECTOR-MESON COUPLINGS TO THE BARYONS. Sugawara, H.; von Hippel, Frank (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 145: 1331-?(May 27, 1966).

Some arguments are presented by which the couplings of the vector mesons to the baryons are fixed. These arguments amount to an extension of the nonet scheme which has already been successfully applied by Okubo and by Glashow and Socolow to the 1^- and 2^+ mass formulas and decays. It is found that, using the vector-meson couplings obtained and the physical vector masses, the following experimental observations are largely accounted for: the proportionality of the electric and magnetic nucleon form factors to each other and to the p-$(N^*_{33})^+$ magnetic-dipole transition form factor; the suppression of backward ϕ production in K^--p experiments; the over-all suppression of ϕ production in π-p experiments; and the isospin independence of the hard core in nucleon-nucleon scattering. The relative leptonic decay rates of the ρ, ω, and ϕ are also estimated, and it is predicted that there will be suppressions in $f'(1500)$ production corresponding to those observed in ϕ production. (auth)

27864 EFFECTIVE MASS OF POSITRONS IN METALS. Hamann, D. R. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 146: 277-81(June 3, 1966).

The self-energy of a positron in an electron gas due to electron-positron correlations is calculated to the lowest order in the dynamically screened interaction. It is shown that the dressed positron quasiparticle can be described by an effective mass, but that the calculated effective mass is much too small to account for that measured by observing thermal effects in positron-annihilation experiments. Corrections due to more complicated self-energy processes and to electron-exchange interactions are estimated and found to be small. (auth)

27865 BRANCHING RATIO $\Gamma(\eta \rightarrow 3\pi^0)/\Gamma(\eta \rightarrow \pi^+ + \pi^- + \pi^0)$. Crawford, Frank S. Jr. (Univ. of California, Berkeley); Lloyd, L. J.; Fowler, Earle C. Phys. Rev. Lett., 16: 907-8(May 16, 1966).

The branching ratio $\Gamma(\eta \rightarrow 3\pi^0)/\Gamma(\eta \rightarrow \pi^+ + \pi^- + \pi^0)$ is determined. The detection efficiency for $\eta \rightarrow \pi^0 + \gamma + \gamma$ is calculated using a method previously used for determining the efficiency for detecting $\eta \rightarrow 3\pi^0$ (Phys. Rev. Letters 10: 546 (1963)) and assuming $r = \Gamma(\eta \rightarrow \pi^0 + \gamma + \gamma)/\Gamma(\eta \rightarrow 3\pi^0) = 1.79 \pm 0.29$. (B.G.D.)

27866 EXACT SUM RULE FOR NUCLEON MAGNETIC MOMENTS. Drell, S. D. (Stanford Univ., Calif.); Hearn, A. C. Phys. Rev. Lett., 16: 908-11(May 16, 1966).

The joining of the dispersion relation for forward Compton scattering and the low-energy theory for Compton scattering with the no-subtraction assumption are used to construct an exact sum rule for nucleon magnetic moments. (B.G.D.)

27867 REGGE RECURRENCES AND π^-p ELASTIC SCATTERING AT 180 DEG. Barger, V.; Cline, D. (Univ. of Wisconsin, Madison). Phys. Rev. Lett., 16: 913-17 (May 16, 1966). (COO-881-62).

The results of a theoretical calculation of the structure of 180° π^-p elastic scattering which are in good quantitative agreement with experimental data are presented. The calculation is founded on hypotheses which lead to a consistent description of the detailed structure of 180° π^-p scattering based on the spin-parity assignments expected from the Regge-recurrence concept. The success of this approach supports in general the theoretical treatment of fermion exchange by Reggeization of the amplitude. (B.G.D.)

27868 QUARK MODEL APPROACH FOR THE SEMILEPTONIC REACTIONS. Albright, C. H.; Liu, L. S.; Tjia, M. O. (Northwestern Univ., Evanston, Ill.). Phys. Rev. Lett., 16: 921-6(May 16, 1966).

A dynamic quark model for the semileptonic weak interactions is proposed. In this model there are two levels of predictions. On the lower level, relations are obtained between amplitudes for processes of a given supermultiplet transition, which is shown to be essentially independent of the quark-model parameters and follow from the underlying supermultiplet symmetry for the fundamental quarks and the assumption that in a baryon or meson semileptonic reaction, only one quark (or antiquark) makes the beta trans-

tion. These symmetry predictions are found to be in generally good agreement with experiment. On a higher level, reasonable predictions are accomplished from a palatable set of quark parameters which relate different supermultiplet transitions. These transitions are the basic semileptonic quark transition (3 → 3), baryon-baryon semileptonic transition (56 → 56), pseudoscalar-meson leptonic decays (8 → 1, 8 → 8), and the baryon-baryon semileptonic transition (56 → 70). (B.G.D.)

27869 SMALL-ANGLE HIGH-ENERGY SCATTERING BY DEUTERONS. Franco, Victor (Univ. of California, Berkeley). Phys. Rev. Lett., 16: 944-7(May 23, 1966).

A comparison is presented between the theoretical analysis method based upon the Glauber high-energy approximation with high energy pd differential cross-section measurements of elastic scattering and the sum of inelastic (i.e., p + d → p + n + p) plus elastic scattering. Since small-angle collisions are considered, the single and double scattering effects due to the Coulomb interaction are included. (B.G.D.)

27870 K_{13} FORM FACTORS. Mathur, V. S.; Pandit, L. K.; Marshak, R. E. (Univ. of Rochester, N. Y.). Phys. Rev. Lett., 16: 947-50(May 23, 1966). (UR-875-130)

The current algebra and dispersion techniques are applied to a direct calculation of the form factors $F_+(s)$ and $F_-(s)$ for the K_{l3} decays, and fix the absolute scale as well as the energy dependence. (B.G.D.)

27871 NEAR FORWARD PEAKS IN THE K^-p AND π^-p CHARGE-EXCHANGE SCATTERING. Barut, A. O.; Kleinert, H. (Univ. of Colorado, Boulder). Phys. Rev. Lett., 16: 950-2(May 23, 1966).

The K^-p and π^-p charge exchange scatterings, being the differences of two isospin smplitudes, are shown to be very sensitive to the changes in the relative phase, as a function of t (square of the momentum transfer in the center-of-mass frame), of the two isospin amplitudes and accounts in a simple way for the behavior of the charge-exchange scattering. Since elastic scatterings are not sensitive to this relative phase, the relative phase is measured in the charge-exchange scattering in an attempt to explain the diffraction peaks. (B.G.D.)

27872 EXCHANGE-DEGENERACY CLASSIFICATION OF REGGE TRAJECTORIES AND THE TOTAL CROSS SECTIONS. Ahmadzadeh, Akbar (Univ. of California, San Diego, La Jolla). Phys. Rev. Lett., 16: 952-5(May 23, 1966).

An analysis of the meson-nucleon, and nucleon-antinucleon total cross sections is presented. The analysis is based on Regge trajectories whose factorized reduced residues are related by SU(3) symmetry. The assumption of exchange degeneracy, with respect to the signature as hypothesized by Arnold, and that the residues, as well as the trajectory functions, exhibit degeneracy also is made. The aim is to show that the experimental data on total cross sections are in agreement with this hypothesis, thereby raising the possibility of reducing the number of parameters in Regge-pole phenomenology. (B.G.D.)

27873 K ANTI K DECAYS OF THE φ MESON UNDER CURRENT-COMMUTATION RELATIONS, PARTIALLY CONSERVED-AXIAL-VECTOR-CURRENT HYPOTHESIS, AND SU(6) SYMMETRY. Wada, W. W. (Ohio State Univ., Columbus). Phys. Rev. Lett., 16: 956-9(May 23, 1966). (COO-1545-3).

The widths are calculated for the K^+K^- and K_1K_2 decays of the φ meson by means of the current-commutation relations that generate the algebra of SU(3) ⊗ SU(3) group, the partially conserved-axial-vector-current (PCAC) hypothesis for the K mesons, and SU(6) symmetry. Within the general scheme, the ratio of the widths are calculated for the $\gamma\pi^+\pi^-$ and $\gamma\gamma$ decays of the η meson. (B.G.D.)

27874 POLARIZATION AT FORWARD ANGLES AND AN INVESTIGATION OF STRUCTURE IN πN, KN, AND NN ELASTIC SCATTERING. Yokosawa, A. (Argonne National Lab., Ill.). Phys. Rev. Lett., 16: 1019-22(May 30, 1966).

The structure in πN, KN, and NN elastic scattering is investigated by measuring the polarization at forward angles. Using the polarization data combined with that of the differential cross section the spin and parity of N* are determined. (B.G.D.)

27875 OBSERVATION OF AN ENHANCEMENT IN THE I = 0 $K_1^0K_1^0$ SYSTEM AT 1068 Mev. Crennell, David J.; Kalbfleisch, George R.; Lai, Kwan Wu; Scarr, J. Michael; Schumann, Thomas G.; Skillicorn, Ian O.; Webster, Medford S. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett., 16: 1025-9(May 30, 1966).

The observation of an enhancement in the $K_1^0K_1^0$ spectrum with strangeness zero, isospin zero, even parity, and even charge conjugation, which is referred to as the S*, is reported. The mass of the S* is 1068 ± 10 Mev with a width of 80 ± 15 Mev, and a zero spin is favored by analysis. The cross section for S* production with both K_1^0 decays observed in the reaction $\pi^- + p \rightarrow n + S^*$ where $S^* \rightarrow K_1^0K_1^0$ is approximately 1.5 μb at 6 Bev/c. The difference between S* and the previously reported $K_1^0K_1^0$ threshold effect in lower energy experiments is discussed. (B.G.D.)

27876 DISCOVERY OF ELECTRON SPIN. Goudsmit, S. A. (Brookhaven National Lab., Upton, N. Y.). pp 1-11 of Physikertagung 1965 Frankfurt (M)-Hoechst, Okt. 4-9. Plenarvortraege. Stuttgart, B. G. Teubner Verlagsgesellschaft mbH, 1965. (BNL-9497).

A brief personalized history is given of the experiments, studies, and conversations leading to the discovery of the concept of electron spin. (J.S.R.)

27877 PROTON-PROTON INTERACTION IN THE Gev REGION. Hama, Yogiro (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 35: 261-80(Feb. 1966).

The proton-proton interaction at very small distances is studied by analyzing the elastic scattering data near 2 and 3 Bev. The explicit inclusion of the one-pion-exchange contribution in the high-angular-momentum states and that from the one-boson exchange in the intermediate-angular-momentum states together with the assumption that the absorption coefficients can be represented by a smooth function of the orbital angular momentum l allowed a determination of the phase shifts for lower-angular-momentum states. Three independent solutions were found at each energy considered, which are smoothly connected with solutions at lower energies. The form of the absorption is such that in general its maximum is in the $^1D_2$ state. With respect to the real phase shifts, all of the solutions are consistent with the presence of a strongly repulsive core in the $^1S_0$ state, and solutions were found which suggest a repulsive core also in the triplet odd states. The strong spin dependence of the interaction is stressed and this is also discussed in connection with the forward scattering amplitude. Predictions of several triple scattering parameters are given which may eliminate the ambiguity of the solutions found. (auth)

27878 $\Delta S = -\Delta Q$ TRANSITION, $\Delta I = \frac{1}{2}$ RULE AND CP VIOLATION IN KAON LEPTONIC DECAYS. Tsai, S. Y. (Osaka Univ.). Progr. Theoret. Phys. (Kyoto), 35: 281-7 (Feb. 1966).

A model for the strangeness changing leptonic decays is proposed, in which the presence of the $\Delta S = -\Delta Q$ transition is shown to be compatible with the predictions of the well-known $\Delta I = \frac{1}{2}$ rule for both K_{13} and K_{14} decays, provided that CP invariance is "maximally" violated in that transition. Some remarks on the sigma β decay are given. (auth)

27879 BINDING FORCES BETWEEN QUARKS. Kinoshita, Kisei (Tokyo Univ.); Kinoshita, Yukiko. Progr. Theoret. Phys. (Kyoto), 35: 330-1(Feb. 1966).

The properties of binding forces between the fundamental quark triplet are studied to discover why baryons viewed as (qqq) and mesons as $(q\bar{q})$ are light while other systems have no light composite states. (J.F.P.)

27880 CURRENT PROBLEMS IN PARTICLE PHYSICS. McMillan, Edwin M. (Univ. of California, Berkeley). Science, 152: 1210-15(May 27, 1966).

The basic nature and philosophy of particle physics and

the current theories and experiments of particle physicists are discussed, with a few problems outlined as illustrations. (B.G.D.)

27881 DISPERSION-RELATION TREATMENT OF THE LOW-ENERGY PION-NUCLEON SCATTERING. Ning, Hu (Peking Univ.). Wu Li Hsueh Pao, 22: 325-33(Mar. 1966). (In Chinese).

The relation between the subtracted dispersion relations for the low-energy pion-nucleon scattering and the usual Lagrangian formulation under the renormalization treatment is discussed. It is shown that the subtraction actually represents the renormalization of the interaction constants. Using the subtracted dispersion relations the problem of the s-wave pion nucleon scattering is treated. The result shows that the interaction between the pion and the nucleon should be of the pseudovector type rather than the pseudoscalar type. (auth)

27882 ANOMALOUS INTERACTION, LEPTON STRUCTURE, AND μ-e MASS DIFFERENCE. Lo, Liau-fu (Inner Mongolian Univ., China); Lu, Tan; Yang, Kuo-shen. Wu Li Hsueh Pao, 22: 334-40(Mar. 1966). (In Chinese).

The lepton structure and the μ-e mass-difference is discussed on the basis of the "muonic charge" model. Some general theorems concerning the lepton structure are demonstrated. For example, it is shown that the form factors of "muonic charge" current and of electric current of charged lepton having anomalous interaction are equal. As a result, this lepton would possess a "muonic moment." It is shown that the anomalous interaction self-energy corresponding to "muonic-charge-muonic moment" interaction is the dominant term and the μ-e mass difference is consistent with the known experimental data of the electromagnetic structure of the electron. (auth)

27883 ELECTROPRODUCTION OF THE $N_{\frac{3}{2}}(1238)$ ISOBAR IN RELATIVISTIC SU(6) SYMMETRY. Geshkenbein, B. V. (Inst. of Theoretical and Experimental Physics, State Atomic Energy Commission, USSR). Yadern. Fiz., 3: 549-50(Mar. 1966). (In Russian).

The cross section for the electroproduction of the $N_{\frac{3}{2}}$ (1238) isobar is found on the basis of the relativistic SU(6)-symmetry ($SU(6)_w$). The transition form factor $G_{\Delta p}$ and magnetic form factor of the proton G_M/μ_p coincide for momentum transfers in the region $2F^{-2} < q^2 < 100\ F^{-2}$. (auth)

27884 EVALUATION OF CROSS SECTIONS OF ELECTROMAGNETIC PROCESSES $\pi^- + p \rightarrow \pi^+ + \pi^- + \gamma + n$, $\pi^- + p \rightarrow e^+ + e^- + n$, $\pi^- + p \rightarrow \pi^- + p + e^+ + e^-$ AT π^- MESON KINETIC ENERGY OF 340 Mev. Blokhintseva, T. D.; Grebinnik, V. G.; Zhukov, V. A.; Kravtsov, A. V.; Libman, G.; Nemenov, L. L.; Selivanov, G. I.; Yuan, Jung-fang (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 3: 779-81(Apr. 1966). (In Russian).

The interactions were studied by scanning 250,000 photographs obtained on a hydrogen bubble chamber exposed to a 340-Mev pion beam. Upper bounds are found for the differential cross sections of the reaction $\pi^- + p \rightarrow \pi^+ + \pi^- + \gamma + n$, assuming there is a single event of this type in the region with $M^2 > 1020\ Mev^2/c^4$, where M is the neutral mass in events with the formation of a π^+ meson, and of the reaction $\pi^- + p \rightarrow e^+ + e^- + n$, for the ratio of the e^--e^+-pair invariant mass to the pion mass greater than one. A cross section of 1.6×10^{-30} cm^2 was found for the reaction $\pi^- + p \rightarrow \pi^- + p + e^+ + e^-$ from the analysis of three events. (M.J.T.)

27885 FREE NEUTRINO IN THE COSMOS AND THE PROBLEM OF CP PARITY IN K_2^0-MESON DECAY. Vladimirskii, V. V. (Inst. of Theoretical and Experimental Physics, State Atomic Energy Commission, USSR). Yadern. Fiz., 3: 781-3(Apr. 1966). (In Russian).

The coherent regeneration of K_2^0 mesons in the K_2^0-meson beam via interactions of K^0 mesons with low-energy neutrinos in space is considered. This regeneration could lead to the onset of the CP-violating $K_2^0 \rightarrow 2\pi$ decay. It is shown that, for the expected neutrino flux densities in space, this effect is too small to explain the observed intensity of the forbidden decay. (M.J.T.)

27886 COMPARISON OF THE K^+p SCATTERING DATA WITH THE FORWARD DISPERSION RELATIONS. Zovko, N. (Technische Hochschule, Karlsruhe, Ger.). Z. Phys., 192: 346-50(1966).

The dispersion relations for K^+p forward scattering were evaluated in order to test the compatibility with the experimental data and to obtain an estimation of the effective coupling constant $G^2/4\pi = (G_\Lambda^2 + G_\Sigma^2)/4\pi$. (auth)

27887 A MORE EXACT DETERMINATION OF THE CROSS SECTION FOR THE COMPTON EFFECT ON PROTONS. Baranov, P. S.; Slovakhotov, L. I.; Sokol, G. A.; Shtarkov, L. N. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz., 50: 364-6(Feb. 1966). (In Russian).

Values of the differential cross sections for the Compton effect on protons are presented for gamma quantum energies from ~230 to ~250 Mev. The values were obtained by a more refined treatment of experimental data that were previously obtained. (auth)

27888 POSSIBLE VALUE OF THE Ω^--BARYON QUADRUPOLE MOMENT. Rekalo, M. P. (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Zh. Eksp. Teor. Fiz., 50: 457-8(Feb. 1966). (In Russian).

The isobar model for meson (π) photoproduction on nucleons predicts the presence of a small fraction of $N^{*+} \rightarrow p + \gamma$ decays with the emission of γ-quanta of the electric quadrupole type. The electric quadrupole moments for baryons from the decuplet are calculated using the simplest of the possible transformation properties of the electric quadrupole moment operator relative to the SU(6) group (405-plet). (auth)

27889 MULTIPLE SCATTERING OF ELECTROMAGNETIC WAVES IN AN INHOMOGENEOUS MEDIUM. Kalashnikov, N. P.; Ryazanov, M. I. (Moscow Inst. of Engineering Physics). Zh. Eksp. Teor. Fiz., 50: 459-71(Feb. 1966). (In Russian).

A general method for treating the multiple scattering of electromagnetic waves in matter is proposed, which is based on a solution of the Maxwell equations and in which the radiant energy transfer equations are not used. The motion of a wave packet in a medium with inhomogeneities consisting of black spheres of radius $a \gg \lambda$ is considered as an application. The dependence of the intensity at a depth z is derived as a function of the coordinates or direction of propagation. (auth)

27890 POLARIZATION EFFECTS FOR SCATTERING OF POLARIZED ELECTRONS BY DEUTERONS. Schildknecht, D. Munich, Univ., 1964. 74p. $2.00 Gmelin, AED-Diss. 64-1057.

Density matrices for electrons and protons are calculated and invariance properties of interactions are discussed. Scattering matrix elements of electron-nucleon scattering are determined using Born's approximation. Results indicate that tensor polarization of the recoil deuteron is considerable. The influence of initial deuteron polarization on cross sections is discussed. (Gmelin Inst.)

27891 EXPERIMENTAL STUDIES OF K_2^0 MESON DECAY. Lueers, D. Munich, Univ., 1964. 130p. $2.00 Gmelin, AED-Diss. 64-1058.

Properties of K_2^0 decay are studied using 500 K_2^0 decays in 60,000 bubble chamber pictures. Branching ratios for 3 decay modes are given. (Gmelin Inst.)

27892 STUDIES OF NUCLEON-NUCLEON INTERACTION USING NONLINEAR SPINOR THEORY. Dhar, J. Munich, Univ., 1963. 49p. $2.00 Gmelin, AED-Diss. 63-817.

Nucleon-nucleon interactions are investigated by means of dispersion relations. Only the π and η meson contributions to scattering amplitude are taken into account. Coupling constants π-nucleon and η-nucleon are calculated. Results are in agreement with experimental data. (Gmelin Inst.)

27893 PROCEEDINGS OF THE INTERNATIONAL SYMPOSIUM ON ELECTRON AND PHOTON INTERACTIONS AT HIGH ENERGIES, HAMBURG, JUNE 8–12, 1965. VOLUME II. RESEARCH CONTRIBUTIONS. Hamburg,

Deutsche Physikalische Gesellschaft e. V., 1966. 467p. (CONF-650636).

Separate abstracts were prepared for 76 of the 82 papers included. Four papers were previously abstracted in NSA (19: 31000, 41164; 20: 1018, and 11666). The two remaining papers deal with the leptonic decay of the meson (ρ) and with the photoproduction of meson (μ) pairs and tests of quantum electrodynamics. (G.O.Y.)

For abstracts of individual papers see: 27340–27342, 27676, 27894–27961, 28034, 28165, 28444, and 28445.

27894 PHOTON INTERACTIONS IN A HYDROGEN BUBBLE CHAMBER IN THE ENERGY RANGE 0.5–6.0 Bev. Crouch, H. R. Jr. (Brown Univ., Providence); Hargraves, R.; Kendall, B.; (and others). pp 1-35 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

A detailed study of hyperon, meson, and resonance production by bremsstrahlung in a hydrogen bubble chamber is summarized. (D.C.W.)

27895 PHOTOPRODUCTION OF MESONS IN A HYDROGEN BUBBLE CHAMBER AT ENERGIES UP TO 5,5 Gev. Brall, U. (Technische Hochschule, Aachen); Reimann, G.; Lanius, K.; (and others). pp 36-46 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

The preliminary results of an experimental investigation of the photoproduction of mesons on protons by the exposure of a hydrogen bubble chamber to a bremsstrahlung beam are presented. (D.C.W.)

27896 ELASTIC ELECTRON-DEUTERON SCATTERING AT HIGH MOMENTUM TRANSFERS. de Pagter, J.; Friedman, J.; Kendall, H.; van Speybroeck, L.; Elias, J.; Hartman, G. Contract AT(30-1)-2098. pp 50-2 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

A program to determine the elastic electron-deuteron scattering form factors at high momentum transfer using a 6-Bev electron synchrotron is summarized. Preliminary results are presented. (G.O.Y.)

27897 EXPERIMENTAL EVIDENCE FOR A POSSIBLE MESON-EXCHANGE CONTRIBUTION TO ELASTIC ELECTRON-DEUTERON SCATTERING. Buchanan, C. D.; Yearian, M. R. (Stanford Univ., Calif.). Contract [Nonr 225(67)]. pp 53-60 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

The cross sections for magnetic (elastic) electron-deuteron scattering at $q^2 = 6.0$ 7.0, 8.0, and $12F^{-2}$, where q is the four-momentum transfer, were measured. Elastic scattering was also observed at these q^2 values, as well as at $q^2 = 20.0F^{-2}$. The analysis of the data indicates that the simple impulse approximation model of the deuteron, incorporating the best possible values for the nucleon form factors, is inadequate to explain the experimental results. (D.C.W.)

27898 RELATIVISTIC THEORY OF THE ELECTRODISINTEGRATION OF THE DEUTERON AND NEUTRON FORM FACTORS. Gourdin, M.; Le Bellac, M.; Renard, F. M.; Tran Thanh Van, J. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). pp 64-9 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

A covariant theory of electrodisintegration is outlined with which neutron form factors can be obtained from experimental data on electron-deuteron interactions. The theory satisfies gauge invariance and Lorentz invariance. Some results are presented. (D.C.W.)

27899 ELASTIC AND INELASTIC ELECTRON SCATTERING. Gourdin, M. pp 69-72 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

A general analysis is presented of the coefficients A and B in the formula $d\sigma/d\sigma_{Mott} = A(q^2) + B(q^2)\ tg^2\ \theta/2$ for the angular distribution of the electrons in electron elastic scattering according to the one-photon-exchange approximation. The analysis is done in terms of physical form factors. An expression for the electron inelastic scattering cross section, in the one-photon-exchange approximation, is also included. (G.O.Y.)

27900 CORRECTIONS TO INELASTIC ELECTRON-DEUTERON-SCATTERING. Breitenlohner, P.; Hoelzl, K.; Kocevar, P. (Univ., Graz). pp 73-8 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

A more rigorous calculation of the cross section for inelastic electron-deuteron scattering is outlined. The corrections for final-state interaction are considered in detail. (D.C.W.)

27901 ON THE NONRELATIVISTIC APPROXIMATIONS OF THE DIRAC EQUATION. Breitenlohner, P. (Univ., Graz). pp 78-81 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

Some nonrelativistic approximations of the Dirac equation are briefly discussed. (G.O.Y.)

27902 POLARIZATION EFFECTS IN ELASTIC ELECTRON-DEUTERON SCATTERING. Schildknecht, D. (Univ., Munich). pp 81-3 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

The results of a calculation of the polarization of the deuteron after scattering are presented. The deuteron was treated as a spin-1 particle interacting with the electron in the first Born approximation. (D.C.W.)

27903 REMARKS ON THE DEUTERON FORM FACTORS. Zingl, Harald F. K. (Univ., Graz). pp 84-6 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

The deuteron form factors are discussed in terms of the nonrelativistic Pauli equation. The Darwin term of this equation is discussed with Dirac form factors, and a test for the relativistic terms of the Pauli equation and for the D-state probability is given. (G.O.Y.)

27904 RADIATIVE CORRECTIONS TO ELECTRON-PROTON SCATTERING. Bartl, A. (Univ., Graz). pp 86-91 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

The radiative corrections to electron-proton scattering were calculated for the case in which the electron is detected and the case in which the proton is detected. (D.C.W.)

27905 RADIATIVE CORRECTIONS TO e-p-COINCIDENCE EXPERIMENTS. Kohaupt, R. D. (Institut fuer Experimentalphysik, Hamburg). pp 91-4 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

A brief description of radiative corrections to electron-proton scattering is given for experiments in which the final particles are detected in coincidence and both the angles and the energies of the outgoing particles are measured. (G.O.Y.)

27906 MULTIPLE PHOTON RADIATIVE CORRECTIONS TO HIGH ENERGY ELECTRON SCATTERING. Lomon, E. L. (Massachusetts Inst. of Tech., Cambridge). pp 94-7 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies.

Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

Some experimental tests of the prediction of quantum electrodynamics for electron scattering at very high resolution are outlined. (G.O.Y.)

27907 PRODUCTION OF NUCLEON ISOBARS IN HIGH ENERGY PROTON-PROTON AND ELECTRON-PROTON COLLISIONS. Bellettini, G.; Cocconi, G.; Diddens, A. N.; Lillethun, E.; Scanlon, J. P.; Wetherell, A. M. (CERN, Geneva). pp 97-105 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

The results of some measurements on proton-proton inelastic scattering at small momentum transfers are summarized. Some of these results are compared with data on the reaction $e + p \rightarrow e + p^*$ at corresponding momentum transfers to examine the qualitative similarities and differences in these two methods of producing excited nucleon states. (G.O.Y.)

27908 COINCIDENCE MEASUREMENTS ON ELASTIC ELECTRON-PROTON SCATTERING. Behrend, H. J.; Brasse, F. W.; Engler, J.; Ganssauge, E.; Hultschig, H.; Galster, S.; Hartwig, G.; Schopper, H. pp 105-12 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

Some coincidence measurements on elastic electron-proton scattering at momentum transfers up to $40F^{-2}$ and at scattering angles from 54 to 74° are summarized. The cross sections were obtained as a function of momentum transfer. The form factors obtained were also used to calculate the cross sections. (D.C.W.)

27909 REPORT ON THE INELASTIC ELECTRON SCATTERING PROGRAM AT STANFORD. Lynch, H. Allaby, J. V.; Ritson, D. (Stanford Univ., Calif.). pp 112-20 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

A series of measurements of the cross section for inelastic electron-proton scattering is summarized in which only the momentum and scattering angle of the outgoing electron were observed. Measurements were made for constant values of the final electron energy and the square of the four-momentum transfer in small steps of equivalent photon energy. (D.C.W.)

27910 MEASUREMENTS ON POSITIVE PION ELECTROPRODUCTION IN THE REGION OF THE FIRST RESONANCE. Berkelman, K.; Akerlof, C. W.; Ash, W. W.; Tigner, M. (Cornell Univ., Ithaca, N. Y.). pp 120-3 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

The preliminary results of an investigation of the electroproduction of single mesons (π^+) on protons are presented. A liquid hydrogen target was exposed to a 2.2-Bev electron beam, and the directions of the scattered electron and the meson (π^+) were defined. The objective was to verify the azimuthal asymmetry of meson (π^+) photoproduction about the momentum transfer direction as predicted from the photon polarization and the multipole amplitudes in the region of the first resonance. (D.C.W.)

27911 COINCIDENCE MEASUREMENT OF THE ELECTROPRODUCTION OF NEUTRAL PIONS FROM PROTONS. Kikuchi, R. (Tohoku Univ., Japan); Baba, K.; Kaneko, S.; Fuke, K.; Kobayashi, Y.; Yamakawa, T. pp 124-7 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

The results of a preliminary experiment on the electroproduction of neutral pions from protons at an incident electron energy of 593 Mev are presented. (G.O.Y.)

27912 NEW FIT TO THE NUCLEON FORM FACTORS. Dudelzak, B.; Lehmann, P. (Ecole Normale Superieure, Orsay, France). pp 127-33 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

The results of an attempt at fitting some experimental data by using a four-pole Clementel-Villi representation of the nucleon form factors are presented. (G.O.Y.)

27913 PHOTOPRODUCTION OF ETA MESONS AROUND 1 Bev. Heusch, C. A.; Prescott, C. Y.; Bloom, E. D.; Rochester, L. S. (California Inst. of Tech., Pasadena). pp 141-51 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

An experimental investigation of the interaction $\gamma p \rightarrow p\eta^0$ at photon energies between 950 and 1100 Mev is summarized. Some preliminary results for the cross section of the interaction are presented. (D.C.W.)

27914 ETA PHOTOPRODUCTION IN THE REGION FROM THRESHOLD TO 900 Mev. Prepost, R.; Lundquist, D.; Quinn, D. (Stanford Univ., California). pp 152-8 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

The differential cross section of the interaction $\gamma + p \rightarrow \eta^0 + p$ was measured in 50-Mev intervals from threshold to 900 Mev. The interpretation of the results in terms of possible contributing partial waves is briefly discussed. (G.O.Y.)

27915 PHOTOPRODUCTION OF THE η-PARTICLE. Bacci, C.; (Univ., Rome. INFN, Rome); Penso, G.; Salvini, G.; Mencuccini, C.; Silvestrini, V. pp 158-67 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

The preliminary results of an investigation of meson (η) photoproduction in the energy range from 0.75 to 1.00 Bev and at angles of 100 to 120° cms are presented. (D.C.W.)

27916 HIGH ENERGY PHOTOPRODUCTION OF NEUTRAL RHO MESONS. Lanzerotti, L. J.; Blumenthal, R. B.; Ehn, D. C.; Faissler, W. L.; Joseph, P. M.; Pipkin, F. M.; Randolph, J. K.; Russel, J. J.; Stairs, D. G.; Tenenbaum, J. (Harvard Univ., Cambridge, Mass.). pp 167-72 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

The photoproduction of meson (π) pairs was investigated for invariant pair masses in the range from 0.3 to 1.5 Bev. The cross section for meson (ρ) production was found to be large and to be dominated by a diffraction-like mechanism. (D.C.W.)

27917 ELECTROPRODUCTION OF π-MESONS AND PHOTOPRODUCTION OF DIPIONS. Blechschmidt, H.; Elsner, B.; Heinloth, K.; Ladage, A.; Rathje, J.; Schmidt, D. pp 173-7 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

The electroproduction of mesons (π) was investigated using 5.2-Bev/c electrons and detecting the scattered electron in coincidence with at least one meson (π). At the same time, the photoproduction of dipions was investigated using bremsstrahlung produced by the electrons in the hydrogen target. (D.C.W.)

27918 PRODUCTION OF PIONS (±) BY TAGGED PHOTONS IN THE 2 TO 5 Gev RANGE. Caldwell, D. O.; Dowd, J. P.; Heinloth, K.; Sherwood, T. R. pp 178-84 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

The production of mesons ($\pi^{\pm}$) by photons of 2 to 5 Bev was studied using a spark-chamber spectrometer to measure the pion momentum and a counter-hodoscope spectrometer to determine the incident photon momentum. Both elastic pion photoproduction and inelastic processes

were investigated. The missing mass of the particles produced with the detected pion and the four-momentum transfer to the nucleon were determined with good accuracy. (G.O.Y.)

27919 THE PHOTOPRODUCTION OF CHARGED PIONS IN HYDROGEN AND CARBON FOR PHOTON ENERGIES UP TO 6 Bev. Blanpied, W. A.; Greenberg, J. S.; Hughes, V. W.; Kitching, P.; Lu, D. C.; Minehart, R. C. (Yale Univ., New Haven). pp 185-92 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

The photoproduction of charged pions in C and H was investigated for photon energies up to 6 Bev. The results are discussed in terms of the one-pion-exchange model. (G.O.Y.)

27920 THE PHOTOPRODUCTION OF CHARGED K MESONS AND EVIDENCE FOR NEW HIGH MASS HYPERONS. Greenberg, J. S.; Blanpied, W. A.; Hughes, V. W.; Kitching, P.; Lu, D. C.; Minehart, R. C. (Yale Univ., New Haven). pp 192-200 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

The results of an investigation of the photoproduction of mesons ($K^{\pm}$) at production angles of 5, 7.5, and 10° in the laboratory system and at meson (K) momenta of 2.63 and 3.15 Bev/c are presented. The results are compared with the predictions of one-meson-exchange models. Some evidence for the existence of massive hyperon resonances was obtained. (D.C.W.)

27921 REACTION $\gamma + p = \bar{n} + d$. Gettner, M. (Northeastern Univ., Boston); Rothwell, P.; von Goeler, E.; Weinstein, R.; Garelick, D. pp 200-3 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

The problems of detecting deuterons in a background of 10^4 to 10^5 protons and pions per deuteron were studied. Charged-particle production by a 5-Bev bremsstrahlung beam on a 0.25-in. graphite target at 30° in the laboratory system was investigated. (D.C.W.)

27922 PHOTOPRODUCTION OF K^+ MESONS FROM HYDROGEN. Anderson, R. L.; Gabathuler, E.; Jones, D.; McDaniel, B. D.; Mistry, N. B.; Mori, S.; Sadoff, A. J.; Stanton, N. R. (Cornell Univ., Ithaca, N. Y.). pp 203-6 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

The angular distributions of the mesons (K^+) from the interaction $\gamma + p \rightarrow K^+ + \Lambda$ at 1.16 and 1.40 Bev were measured, as well as the angular distribution for the interaction $\gamma + p \rightarrow K^+ + \Sigma^0$ at 1.11 Bev. The differential cross sections for the latter reaction at 1.08, 1.11, and 1.157 Bev were measured at 90° in the cms. (D.C.W.)

27923 PHOTOPRODUCTION OF NEUTRAL PIONS AT Gev ENERGIES. Alvarez, R. (Massachusetts Inst. of Tech., Cambridge); Bar-Yam, Z.; Garelick, D.; Homma, S.; Kern, W.; Lewis, R.; Luckey, D.; Osborne, L. S.; Uglum, J.; Fessel, R. pp 207-8 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

The differential cross section for the photoproduction of mesons (π^0) on protons at 2.0 to 4.8 Bev was measured by detecting recoil protons in coincidence with gamma rays. The differential cross section for the photoproduction of mesons (π^+) was also obtained. (D.C.W.)

27924 PHOTOPRODUCTION OF π^0 ON PROTONS NEAR THRESHOLD. Hitzeroth, W. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). pp 209-16 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

The preliminary results of an investigation of the differential cross section for the interaction $\gamma + p \rightarrow p + \pi^0$ in the energy region near threshold are presented. The recoil protons from interactions in hydrogen gas were detected using nuclear emulsions. (D.C.W.)

27925 EXPERIMENTAL EVIDENCE FOR THE EXISTENCE OF THE PRIMAKOFF EFFECT AND A NEW MEASUREMENT OF THE π^0 LIFETIME. Bellettini, G. (Univ., Pisa); Bemporad, C.; Braccini, P. L.; Foa, L. pp 217-22 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

The coherent photoproduction of mesons (π^0) on lead around the forward direction was investigated. Evidence for the existence of the Primakoff effect was obtained, and a value for the lifetime of the meson (π^0) was determined from the magnitude of the effect. (D.C.W.)

27926 POSITIVE PION PHOTOPRODUCTION WITH COHERENT BREMSSTRAHLUNG. Gorenstein, P. (CNEN, Rome); Grilli, M.; Spillantini, P.; Nigro, M.; Schiavuta, E.; Valente, V. pp 222-7 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

The asymmetry ratio for the interaction $\gamma + p \rightarrow n + \pi^+$ was measured using linearly polarized photons in the energy range between 200 and 250 Mev. (D.C.W.)

27927 PHOTOPRODUCTION OF π^+ ON PROTON AT 0° IN THE ENERGY RANGE 300 TO 600 Mev. Bizot, J. C.; Perez y Jorba, J.; Treille, D. (Ecole Normale Superieure, Orsay, France). pp 227-32 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

An investigation of meson (π^+) photoproduction on protons at 0° is summarized, including the interpretation of the data. (D.C.W.)

27928 PHOTOPRODUCTION OF NEUTRAL PIONS IN THE ENERGY REGION 400–630 Mev. Bacci, C. (Univ. of Rome); Mencuccini, C.; Penso, G.; Salvini, G.; Silvestrini, V.; Spinetti, M.; Stella, B. pp 232-6 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

Some preliminary results of an investigation of the differential cross section for the interaction $\gamma + p \rightarrow \pi^0 + p$ in the energy range between 400 and 630 Mev and at a meson (π^0) emission angle of 135° cms are presented. (D.C.W.)

27929 ELASTIC PHOTOPRODUCTION OF π^0 MESONS FROM DEUTERIUM IN THE ENERGY RANGE FROM 500 Mev TO 700 Mev. Baba, K.; Hatano, S.; Itoh, H.; (and others) (Kyoto Univ.). pp 236-40 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

The photoproduction of π^0 from a liquid deuterium target was investigated at photon energies between 500 and 700 Mev at a laboratory angle of 57.6°. A time-of-flight analysis of the protons and of the deuterons is given along with the differential cross section of the elastic photoproduction of the meson (π^0). The experimental cross sections are analyzed in terms of the π-N phase shifts. (G.O.Y.)

27930 POLARIZATION MEASUREMENTS OF THE RECOIL PROTON FROM π^0 PHOTOPRODUCTION. Lundquist, D.; Allaby, J. V.; Ritson, D. M. (Stanford Univ., Calif.). pp 241-5 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

The polarization of the recoil proton in meson (π^0) photoproduction on hydrogen was measured for photons in the energy range from 500 to 1000 Mev. The results are compared to other experimental data. (G.O.Y.)

27931 PHOTOPRODUCTION OF π^+ MESONS FROM HYDROGEN FROM 0.6 TO 1.2 Gev. Ecklund, S. D.; Walker, R. L. (California Inst. of Tech., Pasadena). pp 249-52 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

Some preliminary experimental results on the angular distribution for the interaction $\gamma + p \rightarrow \pi^+ + n$ at photon energies between 0.578 and 1.248 Bev are presented. The angular distributions were fitted with a Moravcsik polynomial, and the π-N coupling constant was obtained. The effects of the second and third π-N resonances were observed in the qualitative behavior of the angular distributions and in the variation of the Moravcsik coefficients with energy. (D.C.W.)

27932 PHOTOPRODUCTION OF PION PAIRS IN HYDROGEN UP TO 750 Mev. Kusumegi, A. (Tokyo Univ.); Kobayashi, Y.; Murata, Y.; Sasaki, H.; Takamatsu, K.; Masaike, A. pp 253-62 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

The results of an investigation of the interactions $\gamma + p \rightarrow \pi^+ + \pi^- + p$ and $\gamma + p \rightarrow \pi^0 + \pi^+ + n$ at photon energies from 450 to 750 Mev are presented. (G.O.Y.)

27933 π-PAIR PHOTOPRODUCTION BELOW 1 Bev. Allaby, J. V.; Lynch, H. L.; Ritson, D. M. (Stanford Univ., Calif.). Contract [Nonr 225(67)]. pp 262-9 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

The differential cross section for the reaction $\gamma + p \rightarrow \pi^- + \pi^+ + p$ was measured at several angles for photon energies in the range from 550 to 1000 Mev. It was found that the interaction is dominated by the pseudo-2-body photoproduction $\gamma + p \rightarrow \pi^- + N^*$ (1238), especially near the threshold for this process. (G.O.Y.)

27934 CHARGED PION YIELDS FROM e^- + p REACTIONS. Berezin, S. P.; Gugelot, P. C.; Heide, P. Contract Nonr 225(67). pp 269-76 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

The pion momentum distribution for the interactions $e^- + p \rightarrow e^- + n + \pi^+$ and $e^- + p \rightarrow e^- + p + \pi^+ + \pi^-$ was measured for various angles and various incident energies. The differential cross sections were also obtained. The momentum spectrum of the meson (π^+) shows a peak corresponding to the production of the Δ^+ isobar as an intermediate state. (G.O.Y.)

27935 PHOTOPRODUCTION OF π^0-MESONS FROM ^{4}He AT THE THRESHOLD ENERGY. Belousov, A. S.; Rusakov, S. V.; Tamm, E. J.; Tatarinskaja, L. S.; Shareiko, P. N. (Lebedev Physical Inst., Moscow). pp 276-9 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

The reaction $\gamma + {}^4He \rightarrow {}^4He + \pi^0$ was studied for the bremsstrahlung energy range from 160 to 240 Mev. The angular and energy dependence of the decay γ-rays were measured for laboratory angles of 64°, 96°, and 144°. The same characteristics were measured for the interaction $\gamma + p \rightarrow p + \pi^0$ to check the equipment and to determine the ratio of the cross sections for the photoproduction of mesons (π^0) from ^{4}He and from p. (G.O.Y.)

27936 PHOTODISINTEGRATION OF THE DEUTERON FROM 100 TO 420 Mev. Kissler, K. H.; Kose, R.; Paul, W.; Stockhorst, K. (Univ., Bonn). pp 280-6 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

The photodisintegration of the deuteron was studied using photon energies of 100 to 420 Mev and detecting the proton and neutron in coincidence. The excitation curves for seven different proton angles were measured and were compared with similar data. (G.O.Y.)

27937 MEASUREMENT OF THE POLARIZATION OF THE RECOIL PROTON FROM THE PHOTOPRODUCTION OF NEUTRAL PIONS ON HYDROGEN IN THE REGION OF THE FIRST RESONANCE. Althoff, K. H.; Kramp, K.; Matthaey, H.; Piel, H. (Univ., Bonn). pp 286-91 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

The polarization of the recoil proton from the photoproduction of mesons (π^0) on hydrogen was measured at a fixed photon energy of 360 Mev and at different pion angles between 58° and 105°. The preliminary results of these measurements are presented and are compared with other experimental results. (G.O.Y.)

27938 BACKWARD ANOMALY IN π^0 PHOTOPRODUCTION. Hearn, A. C. (Rutherford High Energy Lab., Didcot, Eng.); Schaerf, C. pp 292-6 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

An anomaly was previously observed in the angular distributions for meson (π^0) photoproduction on hydrogen in the region of high momentum transfer (backward region). It is shown that the observed enhancement may be attributed to the effect of the crossed nucleon and crossed π-N isobar exchanges. The results of analysis of the data on the assumption that up to three poles are contributing in the backward region are presented. (D.C.W.)

27939 TEST OF TIME REVERSAL INVARIANCE IN PHOTOPRODUCTION. Dietz, K. (CERN, Geneva); Gehlen, G. v. pp 297-9 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

A method for testing time reversal invariance by measuring the polarization of the recoil neutron in meson (π^+) photoproduction is proposed. (G.O.Y.)

27940 PHENOMENOLOGICAL THEORY OF SINGLE-PION ELECTROPRODUCTION. Berkelmann, Karl (Cornell Univ., Ithaca, N. Y.). pp 299-303 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

A phenomenological framework for the interpretation of high energy pion electroproduction experiments is presented. It is shown that such measurements can be used to obtain the quantum numbers of excited baryon states and the corresponding electromagnetic transition form factors. (G.O.Y.)

27941 ELECTROPRODUCTION OF π MESONS AND THE COMPTON SCATTERING ON NUCLEONS WITH AN ISOBARIC MODEL. Gourdin, Michel (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). pp 304-8 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

Compton scattering on nucleons was analyzed for the electroproduction of mesons (π) using an isobaric model. The theoretical results were compared with available experimental data. (G.O.Y.)

27942 ELECTROPRODUCTION OF K^0-MESONS. Joos, H.; Muetter, K. H. (Deutsches Elektronen-Synchrotron, Hamburg). pp 308-12 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

The theoretical bases for the investigation of the electromagnetic properties of the meson (K^0) by the electroproduction of mesons (K^0) are outlined. (D.C.W.)

27943 ELECTROPRODUCTION OF NUCLEON RESONANCES. Bjorken, J. D.; Walecka, J. D. (Stanford

Univ., Calif.). pp 312-15 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

The differential cross section for the interaction $e + p \rightarrow e + p^*$, where p^* is a nucleon resonance, was calculated. The two inelastic form factors describing this cross section are expressed in terms of three amplitudes characterizing the (p,p^*) electromagnetic vertex. The kinematic and analytic structure of the three amplitudes as a function of q^2 are discussed, as well as the implications of some models of the nucleon. (G.O.Y.)

27944 ABSORPTIVE CORRECTIONS IN PERIPHERAL PHOTOPRODUCTION OF ρ^0-MESONS. Kramer, G.; Schilling, K. (Institut fuer Experimentalphysik, Hamburg). pp 316-19 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

The results of a study of the peripheral photoproduction of mesons (ρ^0) with scalar and pseudoscalar exchange are presented. The absorptive final-state interactions of the meson (ρ^0) with the proton were taken into account by multiplying the Born partial-wave amplitudes in the impact-parameter approximation with the square roots of the S-matrix elements of elastic scattering in the final state. (G.O.Y.)

27945 ANALYSIS OF PION-PHOTOPRODUCTION IN THE REGION OF THE FIRST PION-NUCLEON RESONANCE. Schmidt, Winfried (Kernforschungszentrum, Karlsruhe, Ger.). pp 323-8 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

The angular distribution for the interaction $\gamma + p \rightarrow n + \pi^+$ was calculated using the method of fixed-t-dispersion relations. The results were compared with experimental data. (D.C.W.)

27946 ANALYSIS OF PION-PHOTOPRODUCTION IN THE REGION OF THE SECOND PION-NUCLEON RESONANCE. Schmidt, W. (Kernforschungszentrum, Karlsruhe, Ger.); Schwiderski, G.; Wunder, H. pp 329-38 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

The photoproduction of mesons (π) in the region of the second π-N resonance was analyzed using an extension of an analysis by the method of fixed-t-dispersion relations of meson (π) photoproduction in the region of the first π-N resonance. (D.C.W.)

27947 ELECTROPRODUCTION OF THE N*. Kessler, Paul; Lachaux, Raymond (College de France, Paris). pp 339-42 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies'. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

The differential cross section for the interaction $e + N \rightarrow e + N + \pi$ at the energy of the N^*_{33} resonance was calculated using an isobaric model. (G.O.Y.)

27948 COMPTON EFFECT ON PROTON BY LINEARLY POLARIZED γ-RAYS AT THE FIRST RESONANCE, AT 90° IN THE CENTER OF MASS. Barbiellini, G.; Capon, G.; Murtas, G. P. (CNEN, Rome). pp 343-8 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

The Compton effect on protons was investigated using the linearly polarized photons of a coherent bremsstrahlung beam that was obtained from a diamond radiator. (D.C.W.)

27949 ANGULAR DISTRIBUTIONS IN THE PROTON COMPTON SCATTERING AT γ-RAY ENERGIES OF 215 AND 248 Mev. Baranov, P. S.; Kuznetsova, V. A.; Slovokhotov, L. I.; Sokol, G. A.; Shtarkov, L. N. (Lebedev Physical Inst., Moscow). pp 348-52 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

The results of an investigation of the angular distribution for proton Compton scattering at 215 and 248 Mev are presented. The results are in agreement with previous observations. (D.C.W.)

27950 PROTON COMPTON SCATTERING MEASUREMENT FROM 400 Mev TO 1100 Mev NEAR 90 DEG IN THE C.M. Rust, D. R.; Eisenhandler, E.; Mostek, P. J.; Silverman, A.; Sinclair, C. K.; Talman, R. M. (Cornell Univ., Ithaca, N. Y.). pp 352-5 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

The differential cross section for elastic photon-proton scattering was measured for incident photon energies between 0.45 and 1.05 Bev. (G.O.Y.)

27951 INELASTIC NUCLEAR EFFECTS ON MUON PAIR PRODUCTION AT HIGH ENERGY. Smith, H. P.; Malenka, B. J. (Northeastern Univ., Boston). pp 356-9 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

Inelastic nuclear effects on muon pair production at high energy are investigated by assuming that the quasi-elastic single-particle excitations to the continuum make the principal contribution to the inelastic cross section. (G.O.Y.)

27952 RATIO OF THE CROSS SECTIONS FOR PHOTOPRODUCTION OF ASYMMETRIC MUON AND ELECTRON PAIRS IN HYDROGEN AND CARBON. Hughes, V. W.; Blanpied, W. A.; Greenberg, J. S.; Kitching, P.; Lu, D. C.; Minehart, R. C. (Yale Univ., New Haven, Conn.). pp 361-8 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

The preliminary results of an investigation of the photoproduction of electron pairs and meson (μ) pairs from carbon and hydrogen are presented. The experimental results are compared with theoretical predictions. (D.C.W.)

27953 SEARCH FOR AN EXCITED ELECTRON. Betourne, C.; Nguyen Ngoc, H.; Perez y Jorba, J.; Treille, D. (Ecole Normale Superieure, Orsay, France). pp 377-9 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

An attempt to observe a heavy electron in electron-proton inelastic scattering at 280 to 980 Mev is summarized. (D.C.W.)

27954 HIGH-ENERGY γ-RAY SOURCE FROM ELECTRON-POSITRON PAIR ANNIHILATION. Tsai, Y. S.; Swanson, S. M.; Iddings, C. K. (Stanford Univ., Calif.). pp 380-7 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

The problems associated with the production of a nearly monochromatic photon source using the interaction $e^+ + e^- \rightarrow 2\gamma$ are investigated. An approximate expression for the differential cross section of the process is derived; numerical results are compared with other theoretical predictions. (G.O.Y.)

27955 RADIATIVE CORRECTIONS TO COLLIDING BEAM EXPERIMENTS. Tsai, Y. S. (Stanford Univ., Calif.). pp 387-92 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

A general procedure for treating the radiative corrections to the two-body final-state problems $e_1 + e_2 \rightarrow A + B$, in e^-e^- or e^+e^- colliding-beam experiments using a spark chamber as a detector, is outlined. (G.O.Y.)

27956 DOUBLE BREMSSTRAHLUNG IN COLLIDING BEAM EXPERIMENTS. Bayer, V. N.; Galitsky, V. M. (Inst. of Nuclear Physics, Academy of Sciences,

Novosibirsk, USSR). pp 393-6 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

A calculation of the cross section for the emission of two photons in electron-electron or electron-positron interactions is outlined. (D.C.W.)

27957 ELECTRON SHOWERS. Luckey, David (Massachusetts Inst. of Tech., Cambridge). pp 397-401 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

The resolution of various counters, as measured under ideal conditions with mono-energetic electron beams, is discussed, together with the measurement of gamma-ray direction. (G.O.Y.)

27958 LATERAL STRUCTURE OF ELECTROMAGNETIC SHOWERS IN MULTIPLATE SPARK CHAMBERS. Bauer, A.; Broecking, D.; Faissner, H.; Karl, H.; Koehmstedt, H.; Stein, J. (Technische Hochschule, Aachen). pp 401-8 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

The lateral structure of electron showers in a multiplate spark chamber was studied and was compared to the lateral structure of gamma showers at the same energies. An optical method and an iterative method for calculating the shower axis are compared. (G.O.Y.)

27959 LATERAL AND LONGITUDINAL DISTRIBUTIONS OF ENERGY LOSSES IN ELECTRON-PHOTON SHOWERS. Murata, Y. (Tokyo Univ.); Nishimura, J.; Kusumegi, A.; Niu, K.; Masaike, A.; Kajikawa, R. pp 417-24 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

The lateral and longitudinal distributions of energy losses in an electron-photon shower were measured using x-ray films sandwiched with various absorber materials. (G.O.Y.)

27960 LASER-INDUCED POLARIZED PHOTON BEAMS ABOVE 0.5 Gev. Milburn, Richard H. (Tufts Univ., Medford, Mass.). pp 445-50 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

A beam of polarized photons was obtained by the Compton scattering of a 0.2-joule ruby laser beam (photon energy 1.78 ev) on a 2-mamp, 6-Bev circulating electron beam. The use of lasers to produce high-energy polarized photon beams is discussed. (G.O.Y.)

27961 PRODUCTION OF COHERENT BREMSSTRAHLUNG IN THE Gev-REGION. Bologna, G.; Lutz, G.; Schulz, H. D.; Timm, U.; Zimmermann, W. pp 455-7 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

Some preliminary results on the production of a polarized photon beam by the reaction of a 3.8-Bev electron beam with an oriented diamond radiator target are presented. (D.C.W.)

Field Theory, Scattering Theory, and Symmetries

See also Elementary Particles and Radiations

27962 (IC-66/36) DEGENERATE REPRESENTATIONS OF NON-COMPACT UNITARY GROUPS. II. CONTINUOUS SERIES. Fischer, J.; Raczka, R. (International Centre for Theoretical Physics, Trieste (Italy)). Apr. 1966. 24p. Dep. mn.

Three degenerate principal series of irreducible unitary representations of an arbitrary non-compact unitary group U(p,q) are derived. These series are determined by the eigenvalues of the first- and second-order invariant operators, the former having a discrete spectrum and the latter a continuous one. The explicit form of the corresponding harmonic functions is derived and the properties of the continuous representations are discussed. (auth)

27963 (IC-66/37) PARTICLE MIXING AND $J^P = 2^+$ MESON DECAYS. Rivers, R. J. (International Centre for Theoretical Physics, Trieste (Italy)). Apr. 1966. 23p. Dep. mn.

Particle mixing for meson fields of arbitrary spin is considered in a field-theoretic context. Expressions for the field renormalization constants and mixing parameters are given in terms of the physical masses, assuming Okubo-type octet breaking. Broken SU(3) coupling constants are evaluated for the 2^+ meson decays and the predicted partial widths compared with experiment. Satisfactory agreement is found. (auth)

27964 (IC-66/49) SATURATION OF THE SU(3) ALGEBRA OF CURRENT DENSITIES. Oehme, R. (International Centre for Theoretical Physics, Trieste (Italy)). May 12, 1966. 9p. Dep. mn.

The SU(3) algebra of vector current densities is saturated with octet and decimet states of baryons at infinite momentum and finite momentum transfer. The results are consistent with those of collinear U(6). They are in good agreement with experiments. (auth)

27965 (JINR-E-2644) ELEMENTARY PARTICLES OF MAXIMUM LARGE MASSES. (QUARKS, MAXIMONS). Markov, M. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 19p. Dep. mn.

In field theory (both in quantum and classical regions) it is possible, taking into account the gravitational field, to derive some expressions for the characteristic masses:

$$m_0 = \left(\frac{\hbar c}{\kappa}\right)^{1/2}, \; m_1 = \frac{e}{\sqrt{\kappa}}$$

An attempt is made to consider these masses as possible maximum values of the elementary particle masses (maximons). It is noteworthy that only for these mass values there arises a peculiar mechanism (gravitational collapse of small masses) which allows to construct resulting systems of arbitrarily small masses out of maximons. The properties of these particles and their possible relation to quarks are discussed. (auth)

27966 (JINR-E-2681) HYPOTHESIS OF CONSERVED TENSOR CURRENTS AND SU(6) GROUP. Ogievetsky, V. I.; Polubarinov, I. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 8p. Dep. mn.

It is shown that conserved tensor currents generate SU(6) transformations. A relationship is established between the constructed currents and the pseudovector currents of the so called algebra of currents. The relativized transformations obtained leave free equations invariant, but should be modified in the case of interaction. In the true theory involving interaction the transformations and currents are likely to become essentially nonlinear. Only if applied to one-particle states and static effects a future true group will be reduced to SU(6). Under the hypothesis that tensor currents are essentially sources of 2^+ fields the fundamental role of the 189 supermultiplet is pointed out. (auth)

27967 (JINR-P-2638) K TEORII KULONOVSKOGO VZAIMODEISTVIYA. (On the Theory of Coulomb Interaction). Tugov, I. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 22p. Dep. mn.

A differential equation in the momentum space was obtained for a many-dimensional Coulomb problem. An equivalence is shown of this equation to the wave equation in a space of constant curvature $K > 0$ for a discrete spectrum $E < 0$ and $K < 0$ for scattering in a field of attraction and in a field of repulsion. Solving Killing's equations gives

generators of the symmetry group of the equation. Possible sets of quantum numbers are investigated. An explicit form of diagonal operators is presented and normalized systems of eigenfunctions of the discrete and continuous spectra were constructed for a number of coordinate systems in the three-dimensional case. When scattering in a field of attraction and in a repulsion field the wave functions are infinite equivalent representations of the Lorentz groups belonging to the principal series of unitary representations. (auth)

27968 (JINR-P-2665) MEZON-BARIONNOE RASSEYANIE VPERED V RELYATIVISTSKOI TEORII SPINOVOI I UNITARNOI SIMMETRII. (Meson-Baryon Forward Scattering in Relativistic Theory of Spin and Unitary Symmetry). Bokov, O. G.; Nguyen Van Hieu; Sredniava, B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 22p. Dep. mn.

All possible relations among meson-baryon scattering amplitudes are systematically studied in the scheme of $SU(6)_w$ symmetry. In the frame of U(6,6) the most general expression including 30 regular and irregular amplitudes is obtained for the forward meson-baryon scattering matrix element, the latter being invariant under $SU(6)_w$. The method applied here differs from that developed by (J. C. Carter, et al., Phys. Rev. Lett. 15, 373(1965)). It is shown that many relations which were obtained by Carter, et al., for the forward meson-baryon scattering cross sections are not the consequences of $SU(6)_w$ as they hold only in the non-relativistic limit, provided only regular amplitudes are taken into account. (auth)

27969 (UCRL-14885-T) EFFECT OF $^3S_1$–$^3D_1$ COUPLING ON THE $^3D_1$ PHASE SHIFT OVER THE 0 TO 320 Mev ENERGY RANGE. Bryan, Ronald (Lawrence Radiation Lab., Univ. of California, Livermore). Apr. 1966. Contract W-7405-eng-48. 11p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

The Schroedinger equation and a phenomenological potential was used to estimate the effect of $^3S_1$–$^3D_1$ coupling on the $^3D_1$ phase shift over the 0- to 320-Mev energy range. (M.O.W.)

27970 PROBABILITY FUNCTIONAL IN SCATTERING PROCESSES. Rzewuski, Jan (Univ. of Wroclaw. Inst. of Physics, Wroclaw). Acta Phys. Pol., 29: 341-53(Mar. 1966).

The generating functional for the scattering probabilities is introduced together with its off mass shell generalization. The consequences which follow for this functional from the causality assumption for the transition amplitudes are studied in some detail. In particular it is shown that the generating functional for the probabilities may be represented by a similar functional integral as the generating functional for the amplitudes although with a modified, nonlocal interaction. The probabilities on the mass shell are given already by the first term in the functional power series expansion of this functional which reduces the whole scattering problem to the calculation of a vacuum polarization term. The functional differential equations for the probability functional are derived and discussed in some detail. (auth)

27971 REMARK ON THE CAUSALITY CONDITION IN MOMENTUM SPACE. Rzewuski, Jan (Univ. of Wroclaw. Inst. of Physics, Wroclaw). Acta Phys. Pol., 29: 355-61 (Mar. 1966).

The causality condition for the generating functional for the off mass shell scattering amplitudes is transformed into momentum space. It is investigated to what extent the high energy asymptotics for this generating functional determines the solution of the causality equation. (auth)

27972 DISTRIBUTION OF NON-CLASSICAL PARTICLES ON AN INTEGRAL SURFACE OF HAMILTON-JACOBI EQUATION. Blaquiere, Augustin (Univ. Paris., Orsay, France). Compt. Rend., Ser. A, 262: 721-3(Mar. 21, 1966). (In French).

Some relations between a generalized Bellman equation, which controls the behavior of particles not necessarily obeying the principle of least action, and the Schroedinger equation are defined. (tr-auth)

27973 INVARIANCE OF THE VACUUM IS THE INVARIANCE OF THE WORLD. Coleman, Sidney (CERN, Geneva). J. Math. Phys., 7: 787(May 1966).

The following theorem is demonstrated: If the vacuum is invariant under the group generated by the space integral of the time component of a local vector current, then the hamiltonian is invariant also. A similar theorem holds for the group generated by the space integral of a space component of a local axial-vector current. (auth)

27974 ADIABATIC SWITCHING IN THE SCHROEDINGER THEORY OF SCATTERING. Dollard, John Day (Palmer Physical Lab., Princeton, N. J.). J. Math. Phys., 7: 802-10(May 1966).

The time-dependent Schrödinger theory of scattering is studied rigorously with the potential V replaced by $e^{-\epsilon|t|}V$. Sufficient conditions are given that the Møller wave-matrices $\Omega^{\pm}$ be obtainable from this theory as $\epsilon \to 0$. The conjecture that this theory can be used to define a reasonable S-matrix when the $\Omega^{\pm}$ do not exist is shown to be false for the Coulomb potential. It is remarked that the Goldberger-Gell-Mann switching procedure also breaks down in this case. (auth)

27975 STRUCTURE OF THE CROSSING MATRIX FOR ARBITRARY INTERNAL SYMMETRY GROUPS. Fairlie, D. B. (Univ. of Durham, Eng.). J. Math. Phys., 7: 811-15(May 1966).

Some properties of crossing matrices are deduced which are independent of the particular symmetry group from which the crossing matrices are derived. In particular, a factorization of any elastic crossing matrix, analogous to the factorization of a rotation matrix in n dimensions is found, and the connection between crossing and unitary matrices elucidated. In the special case of the crossing matrix for elastic scattering of particles which transform as representations of SU_2, as well as the usual consistency requirement that each row should sum to unity, a new consistency requirement on the elements in a given column is proved. As a byproduct of this work, a possibly new quadratic identity for Racah coefficients is exhibited. (auth)

27976 DIRECT-PRODUCT REPRESENTATIONS OF THE CANONICAL COMMUTATION RELATIONS. Klauder, J. R. (Bell Tellephone Labs., Inc., Murray Hill, N. J.); McKenna, J.; Woods, E. J. J. Math. Phys., 7: 822-8 (May 1966).

Direct-product representations of the canonical commutation relations are considered. An irreducible representation is defined on each of the incomplete direct-product spaces (IDPS) of von Neumann. It is proved that two such representations are unitarily equivalent if and only if the corresponding IDPS are weakly equivalent, for which simple analytic tests exist. The matrix element of these representations, coupled with a Friedrichs–Shapiro type of integral, fulfill group orthogonality relations. This classification into unitary equivalence classes also applies to direct-product representations of the canonical anticommutation relations. (auth)

27977 THE PHYSICAL REGIONS OF MANY-PARTICLE PROCESSES. Morrow, Richard A. (Dartmouth Coll., Hanover, N. H.). J. Math. Phys., 7: 844-8(May 1966).

Lorentz invariant expressions, in the form of determinantal conditions, are derived for the physical regions of many-particle processes. They are explicitly solved in the case of five-particle processes and the solutions are exhibited in the planes of pairs of the five independent kinematic invariants. (auth)

27978 IMPLICATIONS OF UNITARITY ON POSSIBLE HIGHER SYMMETRIES. Muzinich, I. J. (Univ. of Washington, Seattle). Contract AT(45-1)-1388. J. Math. Phys., 7: 858-62(May 1966).

Using the covariant spinor formalism for higher-spin particles, it is shown that the only combination of the internal symmetry group and the Lorentz group that is compatible with the unitarity condition is the direct product. Three theorems are proved which severely limit the type of symmetries that are consistent with the unitarity condition. (auth)

27979 SPECTRUM OF THE S OPERATOR. Remler, E. A. (Princeton Univ., N. J.). J. Math. Phys., 7: 871-4(May 1966).

The structure of a scattering operator which describes events above a three-body and below a four-body threshold was studied. It is shown that one can approximate it arbitrarily closely in the norm as the sum of two operators, each having a simple form. Using this decomposition, a general form for the spectral decomposition of this scattering operator is obtained. (auth)

27980 EXCHANGE OF MASSIVE PARTICLES IN THE BETHE-SALPETER EQUATION. Rosner, Jonathan L. (Palmer Physical Lab., Princeton, N. J.). J. Math. Phys., 7: 875-84(May 1966).

The high-energy behavior of the absorptive part A(s) of the forward scattering amplitude in the $g\phi^3$ ladder-graph approximation can be obtained from a homogeneous integral equation. If A(s) grows as s^α, α is the highest characteristic value of this equation. When the mass μ of the exchanged particles is nonzero, the high-g behavior of α is radically different from that in the case of scalar photon exchange. For small g, $\alpha = -1 + g^2a - g^4b + \ldots$, where a is independent of μ. The dependence of b on μ was calculated. (auth)

27981 DETERMINATION OF THE PARAMETERS OF MODEL FIELD THEORIES FROM PHASE SHIFTS AND BOUND-STATES ENERGIES. Fonda, Luciano; Ghirardi, Gian' Carlo (Univ., Trieste, Italy). J. Math. Phys., 7: 906-15(May 1966).

The inversion problem is taken into account and solved in the framework of some models of quantum field theories. Both cases of one and multichannel models are considered. The conditions that must be satisfied by the phase shifts in order that they can be reproduced by the considered models are discussed and relations are derived among the scattering phase shifts, the energies of the bound states and the parameters of the models. It turns out that in certain cases the parameters are completely determined while in other cases some freedom is left. (auth)

27982 FORM FACTOR OF THE FERMI MODEL SPATIAL DISTRIBUTION. Maximon, L. C.; Schrack, R. A. J. Res. Nat. Bur. Stand., 70B: 85-94(Jan.-Mar. 1966).

A useful analytic expression for the form factor $F(q) = \int \rho(r) e^{iq\cdot r} d^3r$ of the Fermi distribution $\rho(r) = \rho_0[1 + e^{(r-c)/a}]^{-1}$ is derived. This expression consists of a simple term with elementary functions plus a rapidly convergent infinite series with terms of alternating sign. Tables of the form factor as a function of q for several values of the parameter c and a, and well as the numerical values of the normalization constant ρ_0 and the rms radius corresponding to these values of the parameters, are also given. (auth)

27983 THEORY OF FINITE SYSTEMS OF PARTICLES. II. SCATTERING THEORY. Van Winter, Clasine (Rijksuniversiteit, Groningen, Netherlands). Kongel. Dan. Vidensk. Selsk., Mat.-Fys. Skr., 2: No. 10, 1-94(1965).

A scattering theory is presented for a nonrelativistic system consisting of a finite number of particles with local two-body interactions. The behavior of the system is studied from the point of view of the theory of Hilbert space. The formalism aims at expressing the scattering of wave packets in terms of the resolvent of the hamiltonian. The starting-point is Jauch's theory of wave-operators, which is summarized. This theory is particularly well suited for describing multichannel processes. It permits an unambiguous definition of reaction channels and is sufficiently general to discuss the scattering, both elastic and inelastic, of any finite number of particles or bound fragments. (J.F.P.)

27984 AN INTEGRAL REPRESENTATION FOR THE FOUR-POINT FUNCTION ANALOGOUS TO THE BERGMAN-WEIL INTEGRAL. Arrhen, Peter (Univ. of Lund, Sweden). Nucl. Phys., 81: 557-74(June 1966).

The fact that the analyticity domain M_4 of the four-point function is bounded by nonanalytic hypersurfaces implies that the Bergman-Weil integral is not applicable to the four-point function. However, as shown by Svensson, there exists a special integral representation for the n-point function which, when applied to the three-point function, can be interpreted as the Bergman-Weil integral. This integral representation is used to obtain a Bergman-Weil-like integral for the four-point function (without local commutativity). This integral relates the value of the four-point function at any point in M_4 to the boundary value of the function on a six-dimensional subset of the boundary of M_4. (auth)

27985 AN APPROACH TO THE PROBLEM OF BOUND STATES. III. Maekawa, T. (Kumamoto Univ., Japan). Nucl. Phys., 81: 623-40(June 1966).

A method developed previously is applied to the cases of the axial-vector and tensor four-fermion interactions. Integral equations for the particle-antiparticle two-body bound system are derived and then analyzed in terms of partial waves. In the special case of contact interaction, solutions are obtained for all possible states. Finally, features of the two-body bound states are summarized for all coupling types, i.e. the scalar, pseudoscalar, vector, axial-vector and tensor interactions. (auth)

27986 GROUP THEORY OF HARMONIC OSCILLATORS. III. STATES WITH PERMUTATIONAL SYMMETRY. Kramer, P.; Moshinsky, M. (Univ., Mexico, Mexico City). Nucl. Phys., 82: 241-74(1966).

An analysis is given for the problem of n particles in a common harmonic oscillator potential. The first objective is to give an analytic procedure for the explicit construction of the states in the $U_{3n} \supset U_3 \times U_n$, $U_3 \supset R_3 \supset R_2$, $U_n \supset U_{n-1} \supset \ldots \supset U_1$ chain of subgroups, where the 3n dimensional unitary group U_{3n} is the symmetry group of the hamiltonian while U_3 is the symmetry group of the harmonic oscillator, R_3 is the ordinary rotation group, and U_n is the unitary group in n dimensions associated with the particle indices. The second and main objective is to construct states with definite permutational symmetry. After taking out the center-of-mass motion the states given in terms of n−1 relative Jacobi vectors will be a basis for irreducible representations of the unitary group U_{n-1} and its orthogonal subgroup O_{n-1}. The characterization of the states is completed with the help of the irreducible representations of the symmetric group S_n, which, through its representations $D^{[n-1,1]}(S_n)$, is a subgroup of O_{n-1}. This implies that the states transform irreducibly under the groups in the chain $U_n \supset U_{n-1} \supset O_{n-1} \supset S_n$ rather than under those in the chain $U_n \supset U_{n-1} \supset \ldots \supset U_1$. The states classified in this way contain as particular cases, those of both the shell and the cluster model. Explicit expressions are given for two, three and four particles. (auth)

27987 SUM RULES FOR THE DECAY OF 35-PLET INTO DECUPLET PLUS OCTET. Zimerman, A. H.; Fagundes, H. V. (Instituto de Fisica Teorica, Sao Paulo, Brazil). Nuovo Cimento (10), 43A: 233-8(May 21, 1966).

"Sum rules" for the decay of a SU_3 35-plet into decuplet plus octet are derived. The consequences of the application of Goldberger-Treiman relations are also considered. (auth)

27988 COMPOSITENESS CRITERION IN FIELD THEORY. II. Choudhury, S. Rai; Srivastava, P. K. (Univ. of Delhi). Nuovo Cimento (10), 43A: 239-43(May 21, 1966).

The following result is proved: for two stable particles having the same quantum numbers, the vanishing of the wave function renormalization constant for one necessarily implies the same for the other. The compositeness criterion both in the field-theoretical and dispersion-theoretical sense loses its absolute significance in such a case. (auth)

27989 VECTOR MESONS IN PRESENCE OF BROKEN SYMMETRY. Englert, F.; Brout, R.; Thiry, M. F. (Univ. Libre, Brussels). Nuovo Cimento (10), 43A: 244-57 (May 21, 1966).

The effect of broken symmetry on the mass of vector mesons which are coupled to conserved currents is studied. The effect is introduced through the self-energy of the vec-

tor mesons. For the case of compact Lie groups, one finds that the vector mesons which acquire mass are those coupled to conserved currents outside the torus of the group. The case of pseudovectors coupled to axial currents is treated analogously. A possible explanation of the approximate degeneracy of the ρ and ω mesons is offered on the basis of this approach. Finally, the relation between the recent work of Lee and independently of Lévy, on the construction of conserved currents, is pointed out. (auth)

27990 PRACTICAL THEORY OF THREE-PARTICLE STATES. II. RELATIVISTIC, SPIN ZERO. Freedman, D. Z.; Lovelace, C.; Namyslowski, J. M. (Imperial Coll. of Science and Tech., London. CERN, Geneva). Nuovo Cimento (10), 43A: 258-324(May 21, 1966).

Covariant equations for the scattering of composite particles are obtained. They are coupled linear integral equations in one variable. The solutions satisfy three-particle unitarity, and all observables in three-particle systems can be expressed in terms of them. The equations are derived from field theory, the basic approximation being that each two-particle subsystem is dominated by its bound states and resonances. However, the final equations involve only the wave functions of the composite particles, and not the original Lagrangian. Overlapping resonances are correctly taken into account, and some three-body forces are also included. The "potential" is essentially the Peierls mechanism, and its imaginary part gives the interference effect between overlapping resonances. The equations are different from and simpler than those of Alessandrini and Omnès, because the relative energies are eliminated in a way compatible with the Landau-Cutkosky rules. Only the equations when the elementary particles are spinless (unequal masses) are given. (auth)

27991 CURRENT COMMUTATORS AND THE MESON BOOTSTRAP. Chan, Hong-Mo (CERN, Geneva). Nuovo Cimento (10), 43A: 347-56(May 21, 1966).

The commutation relations between the time components and divergences of axial vector currents are applied to the meson spectrum suggested by bootstrap. In an idealized system, a unique solution is obtained for the masses and coupling constants of spin-0 mesons, which is in crude agreement with experiment. Of particular interest is the structural similarity between the relations obtained and the usual bootstrap equations. (auth)

27992 INTERACTION PICTURE IN THE ALGEBRAIC QUANTUM THEORY. Montvay, I. (Roland Eoetvoes Univ., Budapest). Nuovo Cimento (10), 43A: 357-67 (May 21, 1966).

It is shown that in the purely algebraic frame for quantum theory there is a possibility of defining the Heisenberg, Schrödinger and interaction picture on the algebra of quasi-local observables. In the different pictures the equations of motion are derived. Some remarks are made concerning the quantum mechanics where the "algebraic frame" can be given explicitly and also checked directly by the usual "Hilbert space approach." (auth)

27993 EXTRACTING THE INFINITE-DIMENSIONAL UNITARY REPRESENTATIONS OF $SU_{2,2}$ IN A FREE-PARTICLE BASIS. I. Ingraham, R. L. (New Mexico State Univ., University Park). Nuovo Cimento (10), 43A: 368-81(May 21, 1966).

The infinite-dimensional unitary irreducible representations of $SU_{2,2}$, which includes the Poincaré group properly, are sought in a basis in which the free-particle quantum numbers momentum, spin, and helicity are sharp. None of the standard representation formalisms apply, such as the Wigner-Mackey semidirect product theory or the Weyl-Cartan theory for semisimple groups, so a general method based on Schur's lemma is used. New insights into the problem of synthesizing the Poincaré group and internal symmetries gained by working out this specific problem are discussed. These are, very briefly: the explanation of continuous mass spectra within supermultiplets; new sources and possibilities for internal quantum numbers; the existence of massive $SU_{2,2}$-invariant fields in spite of the general belief to the contrary ($SU_{2,2} \simeq C \equiv$ conformal group of space-time); the convenience of space-time-dependent similarity transformations to change to familiar bases of irreducible states. (auth)

27994 GENERALIZED LIPPMANN-SCHWINGER SCATTERING EQUATIONS FOR SINGULAR INTERACTIONS. Guettinger, W. (CERN, Geneva); Pfaffelhuber, E. Nuovo Cimento (10), 43A: 423-43(May 21, 1966).

The Lippmann-Schwinger equation is generalized to singular scattering amplitudes coming from unrenormalizable field theories, marginally singular interactions and from singular potentials. The generalization is based on an extension of the Feynman prescription to singular input functions and on a corresponding extension of the potential concept. The connection of the generalized Lippmann-Schwinger equation with partial-wave equations analytically continued in the angular momentum is established. The equation makes sense for repulsive and attractive interactions and also in those cases where no analytic continuation in the angular momentum is possible. Some properties of the generalized Lippmann-Schwinger equation are discussed and a solution method is outlined. A contour integral representation for singular input functions is deduced. (auth)

27995 HIERARCHICAL PRINCIPLE IN PERTURBATION THEORY. Landshoff, P. V.; Olive, D. I.; Polkinghorne, J. C. (Cambridge Univ., Eng.). Nuovo Cimento (10), 43A: 444-53(May 21, 1966).

The hierarchical principle is discussed in perturbation theory in the light of the fact that Cutkosky integrals can have lower-order singularities corresponding to contracting out complete closed loops. It is shown that a strict hierarchical principle can be defined for Feynman integrals in the α-representation but that due to a hitherto overlooked mechanism identically located singularities occur at different levels in the hierarchy. The discussion is illustrated throughout by reference to the icecream-cone diagram. (auth)

27996 EQUAL-TIME COMMUTATORS AND DISPERSION RELATIONS. Fubini, S. (Inst. for Advanced Study, Princeton, N. J.). Nuovo Cimento (10), 43A: 473-82(May 21, 1966).

A new procedure is proposed to transform equal-time commutators of current densities into relativistic dispersion sum rules. The method is illustrated using two physically interesting examples. (auth)

27997 EXTRACTING THE INFINITE-DIMENSIONAL UNITARY REPRESENTATIONS OF $SU_{2,2}$ IN A FREE-PARTICLE BASIS. II. Ingraham, R. L. (New Mexico State Univ., University Park). Nuovo Cimento (10), 43A: 483-98(May 21, 1966).

The infinite-dimensional unitary irreducible representations of $SU_{2,2}$, which includes the Poincaré group properly, are sought in a basis in which the free-particle quantum numbers, momentum, spin, and helicity, are sharp. The mathematical details of the partial solutions are summarized. (auth)

27998 MASS FORMULA FOR $U_6 \otimes U_6$. Akyeampong, D. A. (Imperial Coll. of Science and Tech., London). Nuovo Cimento (10), 43A: 499-506(May 21, 1966).

A mass formula for $U_6 \otimes U_6$ is derived. In particular, it is shown that in order to produce spin-splitting the singlet-contributing terms of the 189 and 405 parts of SU_6, should be introduced. The pseudoscalar coupling constant $g_{ps}^2/4\pi$ is found to be an impressive agreement with experiment. (auth)

27999 REMARKS ON THE SATURATION OF THE SUM RULES OF THE CHIRAL ALGEBRA. Veneziano, G. (Univ., Florence). Nuovo Cimento (10), 43A: 529-32 (May 21, 1966).

The definition of the $N^*N\pi$ coupling constant $f^{*2} = 1/\pi \int_1^\infty (\mathrm{Im}\, f_{33}/q^2)d\omega$ appears to be able to allow a translation of the symmetry predictions into corresponding dynamical predictions. This is further clarified by additional application to the sum rules of Adler and Weisberger and others. (J.F.P.)

28000 CONSTRUCTION OF THE INVARIANT OPERATORS FOR ANY FINITE-PARAMETER LIE GROUP. Pauri, M. (Univ., Parma, Italy); Prosperi, G. M. Nuovo Cimento (10), 43A: 533-7(May 21, 1966).

A general technique is expounded for solving the problem of the actual determination of the invariant (Casimir) operators of the enveloping associative algebra of the Lie algebra of groups such as nonsemisimple groups particularly with regard to the relativistic extension of simple (or semisimple) compact groups of internal symmetry, or, more generally, the invariant operators defined within their ray representations. The method for building up the invariant operators is of primary concern. (J.F.P.)

28001 APPLICATION OF NON-EQUILIBRIUM STATISTICAL MECHANICS TO QUANTUM FIELD THEORY. Prigogine, I.; Mayne, F. (Univ. Libre, Brussels). Phys. Lett., 21: 42-4(Apr. 15, 1966).

The class of problems which belong to Heitler's general theory of damping phenomena may be reformulated in a new way using the recent development of nonequilibrium statistical mechanics. As examples cross sections of Moeller scattering through a real boson and as well as higher order contribution to the life time of an unstable fermion are indicated. (auth)

28002 CURRENT COMMUTATION RELATIONS AND THE $\Delta I = \frac{1}{2}$ RULE. De Baenst, P.; Speiser, D.; Weyers, J. (Univ., Louvain, Belg.). Phys. Lett., 21: 100-2(Apr. 15, 1966).

It is shown that the assumptions of partially conserved axial currents and of a SU(3) × SU(3) current algebra lead to linear relations between hyperon decay amplitudes. These relations are compared with the predictions of the $\Delta I = \frac{1}{2}$ rule. (auth)

28003 NON-INVARIANCE GROUPS FROM INTERMEDIATE COUPLING MODELS. Kuriyan, J. G.; Sudarshan, E. C. G. (Syracuse Univ., N. Y.). Phys. Lett., 21: 106-8(Apr. 15, 1966). (NYO-3399-58).

The noninvariance groups for the symmetric pseudoscalar theory and unitary symmetric pseudoscalar theory are considered. Most of the results of the conventional static SU(6) theory are obtained together with a new relation for electromagnetic mass differences of baryons, which agrees well with experiment. (auth)

28004 CONSERVATION LAWS AND SYMMETRIES. Dass, Tulsi (Univ. of Delhi). Phys. Rev., 145: 1011-18 (May 27, 1966).

The possibility of an arbitrary conserved current, with any tensorial rank and having explicit dependence on space-time variables, being associated with an invariance property is investigated. It is proved, in the Lagrangian formalism of local quantum field theory, that conserved currents satisfying certain reasonable requirements must have the structure prescribed by Noether's theorem. It follows that the continuous group associated with the algebra of conserved current generators must be a symmetry group of the Lagrangian. The space-time dependence of the Bose part of the currents is restricted to be linear, and derivatives of Bose fields higher than the first are assumed to be absent. Making a distinction between invariance of the Lagrangian and that of the field equations, it is proved that an arbitrary conserved quantity has associated with it some invariance property of the field equations; no specific assumptions about the conserved currents or the field equations are required for this. All results are proved for interacting fields. (auth)

28005 STRUCTURE OF RELATIVISTIC TWO-PARTICLE SCATTERING THEORIES. Remler, E. A. (Princeton Univ., N. J.). Phys. Rev., 145: 1145-52(May 27, 1966).

Two-particle scattering theories possessing both Lorentz invariance and a complete space-time description (i.e., a set of generators of the inhomogeneous Lorentz group describing interactions) are treated. The construction of such theories is described starting, not from some assumed hamiltonian, but from another operator, namely, the Cayley transform of the wave operator. This has the advantage that the scattering matrix is predetermined (i.e., known before solving any dynamical equations). The simplest possible model within the context of this approach is considered and solved exactly. This class of models contains the class considered by Jordan, Macfarlane, and Sudarshan. (auth)

28006 WAVE FUNCTIONS FOR PARTICLES OF HIGHER SPIN. Auvil, P. R.; Brehm, J. J. (Northwestern Univ., Evanston, Ill.). Phys. Rev., 145: 1152-3(May 27, 1966).

A simple method is presented for constructing wave functions for particles of arbitrary spin. These are helicity eigenstates and satisfy the Rarita-Schwinger equation. The wave functions are given explicitly. (auth)

28007 SPONTANEOUS SYMMETRY BREAKDOWN WITHOUT MASSLESS BOSONS. Higgs, Peter W. (Univ. of North Carolina, Chapel Hill). Phys. Rev., 145: 1156-63 (May 27, 1966).

A simple relativistic theory of two scalar fields, first discussed by Goldstone, in which as a result of spontaneous breakdown of U(1) symmetry one of the scalar bosons is massless, in conformity with the Goldstone theorem is explained. When the symmetry group of the Lagrangian is extended from global to local U(1) transformations by the introduction of coupling with a vector gauge field, the Goldstone boson becomes the longitudinal state of a massive vector boson whose transverse states are the quanta of the transverse gauge field. A perturbative treatment of the model is developed in which the major features of these phenomena are present in zero order. Transition amplitudes for decay and scattering processes are evaluated in lowest order, and it is shown that they may be obtained more directly from an equivalent Lagrangian in which the original symmetry is no longer manifest. When the system is coupled to other systems in a U(1) invariant Lagrangian, the other systems display an induced symmetry breakdown, associated with a partially conserved current which interacts with itself via the massive vector boson. (auth)

28008 COUPLING CONSTANTS IN BROKEN SU(3). Gautam, V. P.; Ghose, P. (Indian Association for the Cultivation of Science, Calcutta). Phys. Rev., 145: 1166-7 (May 27, 1966).

If one assumes that the violation of unitary symmetry transforms like the eighth component of "unitary spin," the problem of finding the coupling constants reduces to the evaluation of reduced matrix elements. For the reduced matrix elements a very simple and general ansatz is proposed which facilitates the calculation of coupling constants. The conjecture that the interaction which splits the masses also splits the coupling constants, and its "strength" may be estimated from the observed mass splittings is used. As examples the B*BP and VPP coupling constants were calculated using the "spurion octet" technique. The results are compared with the available experimental data and the theoretical data from previous work and are found to be in reasonably good agreement. The technique is applicable to all cases where at least two experimental decay widths are available; if in a particular case the interaction has unique symmetry, a single observed decay width will suffice to fix the scale. (auth)

28009 RE-EXAMINATION OF OCTET DOMINANCE FOR WEAK INTERACTIONS. Tuan, S. F. (Univ. of Hawaii, Honolulu). Contract AT(04-3)-511. Phys. Rev., 145: 1168-71(May 27, 1966).

Octet dominance for weak interactions is re-examined. The basis for discussion is that Cabibbo's octet-weak-current theory in correlating leptonic decays is to be regarded primarily as confirmatory evidence for an octet structure in strong interactions. For nonleptonic decays, a compact procedure for unifying the salient experimental features can be obtained with the assumption of the $\Delta T = \frac{1}{2}$ rule and T-L(2) and time-reversal invariances, but without assuming an explicit hadron current-current structure. The status of R conjugation is briefly analyzed from the present viewpoint. (auth)

28010 AUXILIARY-FIELD METHOD FOR VECTOR FIELD THEORIES. Deo, Bibhuti Bhusan (Indian Inst. of Tech., Kanpur). Phys. Rev., 145: 1171-6(May 27, 1966).

The theory of a neutral vector field is studied by introducing an auxiliary scalar field interacting with it. The vector field propagator of the theory is the same as that obtained by Yang and Lee using the ξ-limiting process. The parameter ξ now enters as an interaction parameter. It is shown further, that it is a gauge parameter and the physical content of the theory is independent of its value. Using a canonical quantization scheme, it is found that the contribution of the scalar field to the energy of the system is negative, and one is forced to introduce an indefinite metric. To have a positive norm of the states for arbitrary interactions involving production of these hypothetical scalar particles, the values of ξ have to be restricted so that the energy of the system is less than $m^2\xi^{-1}$, m being the mass of the vector meson. Most of the formalism can be easily extended to the theory of charged vector mesons. The main purpose of the theory is to investigate the possibility of renormalizing the interactions of the vector field with currents whose divergences do not vanish. It is found that an extra term in the interaction Lagrangian makes the auxiliary-field equation independent of the current and hence of the additional interaction. It is shown that the S matrix cannot produce these particles and that there need be no restrictions on the parameter ξ for this case so long as one deals with initial states having no scalar mesons. (auth)

28011 FIELD-THEORY CALCULATIONS IN BROKEN SYMMETRIES. Moffat, J. W. (Univ. of Toronto). Phys. Rev., 145: 1177-80(May 27, 1966).

A method based on field theory is developed for calculating corrections to broken-symmetry sum rules. The Gell-Mann-Okubo formulas for the bare masses of the baryons and mesons are found from equal-time commutators in the current algebra by using the canonical commutation relations for unrenormalized Heisenberg field operators. The corrections to the Gell-Mann-Okubo formula for the physical masses are calculated from the self-masses in perturbation theory. It is conjectured that the logarithmic infinity occurring in the second-order perturbation-theory result for the baryon self-mass cancels in the mass sum rule, and the corrections can be evaluated. For pure D coupling, the correction in second-order perturbation theory reduces the discrepancy in the baryon-mass sum rule from 12 to 7 Mev. (auth)

28012 GROUP EMBEDDING FOR THE HARMONIC OSCILLATOR. Hwa, R. C.; Nuyts, J. (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., 145: 1188-95(May 27, 1966).

The embedding of the algebra of the invariance group SU(n) for the n-dimensional harmonic oscillator in larger algebras is considered. Among the four classical algebras of rank n, only $\overline{su}(n+1)$ and $\overline{sp}(2n)$ are found possible for this purpose. Specific generators and their commutation relations are examined, and the general Casimir operators are constructed. It is found that the whole spectrum of the harmonic oscillator can be embedded in one representation of $\overline{su}(n+1)$. Depending upon the value of a partition constant c, a finite portion of the spectrum can be embedded in the compact algebra su(n + 1); the remainder is in the noncompact su(n,1). In the case of $\overline{sp}(2n)$, only the noncompact sp(n,R) can include the su(n) of the harmonic oscillator; moreover, the two useful representations of sp(n,R), which are true representations of the universal covering group of Sp(n,R), contain either all the even or all the odd levels of the spectrum. (auth)

28013 MESON SPECTRUM, MASS FORMULA, AND THE QUARK-ANTIQUARK INTERACTION. Sinanoglu, Oktay (Univ. of Miami, Coral Gables, Fla.). Phys. Rev., 145: 1205-11(May 27, 1966).

Higher mesons fit into an L = 1, U(6) ⊗ U(6) "35"-plet $J^P = 0^+$, 1^+, and 2^+ splitting by tensor and spin-orbit interactions. Quantum numbers are assigned with G parities that check and missing ones predicted. Mesons are placed on quark-antiquark ($q\bar{q}$) Regge trajectories. A general mass formula is derived which includes modifications of SU(6)-type splittings in higher supermultiplets, as well as additional quantum numbers related to dynamical groups. General features of an effective ($q\bar{q}$) interaction indicated by the mass spectrum are deduced. Predicted mesons are a $\pi'(640 \mp 40)$, an $\omega'(567 \mp 40)$, and a $\phi'(835 \mp 40)$ all with $J^P = 0^+$; an $\hat{f}(1000 \mp 20)$ and a $\hat{\phi}(1268 \mp 60)$ with $J^P = 1^+$; and a $\phi''(1520 \mp 60)$ with $J^P = 2^+$. There is also an L = 1, SU(6) singlet with $J^P = 1^+$ and mass about 1600 Mev. Resonances that the above system would lead to at still higher energies are discussed. (auth)

28014 DYNAMICAL GROUP AND MASS SPECTRUM. Boehm, A. (International Atomic Energy Agency, Trieste). Phys. Rev., 145: 1212-14(May 27, 1966).

A relation between the representation of the Poincaré group and the (4 + 1) de Sitter group is introduced and it is shown that this relation provides a selection procedure of the mass spectrum, which leads to an experimentally correct mass formula. (auth)

28015 FORMAL THEORY OF n-PARTICLE SCATTERING. Weyers, J. (Univ., Louvain, Belg.). Phys. Rev., 145: 1236-42(May 27, 1966).

A general formalism for n-particle scattering based on Faddeev's approach is given in detail. Two methods are described to obtain compact equations. A brief discussion of unitarity relations is included. (auth)

28016 ELEMENTARY-PARTICLE SPECTRUM. Corben, H. C. (Thompson Ramo Wooldridge Inc., Redondo Beach, Calif.). Phys. Rev., 145: 1251-6(May 27, 1966).

The relativistic quantum theory of the symmetric top implies that the spin J of a particle state can be represented as the sum of three commuting spin operators of lengths given by the positive integers or half-integers n,n', (l + l'). If (l + l') is identified with the isospin, (l' − l) with I_3, $2(n' - n)$ with the strangeness, $(-1)^{2n'}$ with the parity (for baryons), and $(-1)^{n+n'}$ with the G parity (for mesons), the simplest choices of n,n', l,l' lead to a correct description of J, I, I_3, S, G, P for every known strongly interacting meson or baryon state. (auth)

28017 DYNAMICS OF A SINGLET AND AN OCTET OF $D_{\frac{3}{2}}$ MESON-BARYON COMPOSITE STATES. van der Merwe, Paul du T. (Univ. of California, Berkeley). Phys. Rev., 145: 1257-68(May 27, 1966).

The $D_{\frac{3}{2}}$ meson-baryon resonances are investigated on the basis of a multichannel Bethe-Salpeter equation in the unitary symmetry limit. The driving mechanism consists of a box diagram which provides strongly attractive D-state forces corresponding to the unitary singlet and octet states. A reduction of the Bethe-Salpeter equation to a single-dimensional relativistic integral equation which incorporates two-body unitarity is effected along the lines of a method of Blankenbecler and Sugar. The equation is solved by the determinantal method. The model accounts for a singlet and gamma octet of composite states. Some relevant results on the application of the methods of parity and helicity amplitudes to integral equations are given. (auth)

28018 HIGHER MESON AND BARYON RESONANCES IN A SU(18) QUARK MODEL. Peres, Asher (Israel Inst. of Tech., Haifa). Phys. Rev., 145: 1269-72(May 27, 1966).

The three-triplet model of Han and Nambu is extended to a broken SU(18) symmetry. Quarks are assumed to be fermions (only antisymmetric states are allowed). The corresponding representations of SU(18) are reduced with respect to the subgroup SU(6) ⊗ SU(3)' and only SU(3)' singlets are retained. This selects the permissible representations of SU(6). If all quarks are in s states, the $q\bar{q}$ (quark-antiquark) system corresponds to 1 + 35, and the qqq system to 56, as expected (20 and 70 do not appear). The next higher meson resonances consist of $qq\bar{q}\bar{q}$ and come in three sets, corresponding to 1, 35, and (1 + 35 + 189 + 405). Their parity is always positive, and their charge-conjugation properties are tabulated. The negative-parity baryon resonances ($qqq\bar{q}\bar{q}$) can be classified according to 56 and (70 + 1134), while 700 does not appear. Still higher

resonances can easily be obtained by the same method, but the results then become rather dubious, because of the competition of states with nonzero orbital angular momentum, and because of relativistic effects. Finally, the possibility of creating stable isobars with strangeness −6 is mentioned. (auth)

28019 NONEXPONENTIAL DECAYS IN A LEE-TYPE MODEL. Osborn, Hugh (London Univ.). Phys. Rev., 145: 1272-86(May 27, 1966).

A generalization of the Lee model, due to Bell and Goebel, which allows the existence of double poles on the unphysical sheet of the S matrix, is considered. The time behavior of wave packets formed in the infinite past is investigated for two cases, two distinct complex poles, and a single double pole, both being cases in weak coupling so that the unstable state formed is long-lived. It is claimed that the type of process considered represents a typical experimental situation in which the effects of double poles would be investigated. (auth)

28020 CURRENT ALGEBRAS AND SYMMETRIES IN BOOTSTRAP THEORY. Dashen, R. F.; Frautschi, S. C. (California Inst. of Tech., Pasadena). Contract AT(11-1)-68. Phys. Rev., 145: 1287-1301(May 27, 1966). (CALT-68-56).

It was previously shown how, in the bootstrap theory, the currents associated with the hadrons could be determined from a set of self-consistency conditions. It is shown that these "self-consistent" currents satisfy a current algebra. The proof is accomplished without recourse to any approximate model. It includes the interesting case of nonconserved currents. The convergence of sum rules derived from current algebras is investigated in detail, and shown to be most rapid when no "nonbootstrap" terms are present. Using these convergence properties, discussions of how and when current algebras can give rise to hadron symmetries are given. (auth)

28021 GENERALIZED WIGNER-BARGMANN EQUATIONS. Rivers, R. J. (Imperial Coll. of Science and Tech., London). Phys. Rev., 145: 1306-8(May 27, 1966).

Generalized Wigner-Bargmann equations are constructed, for the 143 meson multiplet in U(6,6), that have the effect of replacing the mean U(6,6) mass in the free-field expansion by the appropriate particle masses [in first- or second-order SU(3) breaking]. Used in conjunction with existing generalized equations for the 364 baryon multiplet, modified U(6,6) coupling constants for the three-meson and baryon-meson vertices are derived. (auth)

28022 MIXING EFFECTS IN BARYON SPECTROSCOPY. Altarelli, G. (Univ., Florence); Gatto, R.; Maiani, L.; Preparata, G. Phys. Rev. Lett., 16: 918-20 (May 16, 1966).

The effects of mixings with negative-parity resonant states on the axial couplings of stable baryons are discussed. In particular it is shown that the proposed spin-excitation scheme of higher resonances, according to the noncompact extension U(6,6), does not lead to quite satisfactory predictions. Consideration of other possibilities seems to favor a classification of negative-parity resonances according to $(20, L = 1)^-$, as originally proposed and discussed recently in connection with mixing effects. (B.G.D.)

28023 NONSINGULAR BETHE-SALPETER EQUATION. Levine, Michael; Tjon, John; Wright, Jon (Univ. of California, San Diego, La Jolla). Phys. Rev. Lett., 16: 962-4 (May 23, 1966).

A simpler method for the application of the Bethe-Salpeter equation to the calculation of scattering amplitudes of strongly interacting particles is presented. This method guarantees that unitarity is exactly satisfied in the elastic region. (B.G.D.)

28024 CURRENT COMMUTATORS AND REPRESENTATION MIXING. Harari, Haim (Stanford Linear Accelerator Center, Calif.). Phys. Rev. Lett., 16: 964-7 (May 23, 1966). (SLAC-PUB-173).

The Adler-Weisberger sum rule is shown to be approximately saturated by a set of states consisting of the $\frac{1}{2}^+$ octet, the $\frac{3}{2}^+$ decuplet and an additional multiplet of negative-parity baryon resonances. Using this assumption the correct values of three experimentally measurable quantities, the axial-vector coupling constant in β decay (G_A), the strength of the axial-vector transition between the nucleon and the first resonance N*(1238), and the d/f ratio for the axial-vector current of the baryon octet, are calculated. (B.G.D.)

28025 QUARK MODELS AND HIGH-ENERGY SCATTERING. Lipkin, H. J. (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Rev. Lett., 16: 1015-19(May 30, 1966).

An extension of the quark model is presented in order to show close agreement with experimental data on meson-baryon cross sections at high energies. In addition to the additivity assumption for the two-body quark scattering amplitudes assumed in previous treatments, assumptions are also made on two-body quark-quark and quark-antiquark scattering amplitudes. The basic physical idea is that scattering of 6 to 20 Bev/c mesons is sufficiently close to the asymptotic region so that the two-body scattering amplitudes exhibit some, but not all of the asymptotic features. In particular, it is assumed that the quark-quark amplitudes exhibit these asymptotic features, while they are not present in the quark-antiquark amplitudes. Several different combinations of these assumptions, both with and without SU(3) symmetry, are considered. (B.G.D.)

28026 WEAK-INTERACTION UNIVERSALITY AND OCTET DOMINANCE. Chiu, Y. T.; Schechter, J. (Univ. of Chicago). Phys. Rev. Lett., 16: 1022-5(May 30, 1966).

An attempt is made to calculate the numerical value of the s-wave amplitudes in the Sugawara-Suzuki model of nonleptonic hyperon decays in the current-current picture by summing over a set of single-particle states inserted between the two currents. (B.G.D.)

28027 SYMMETRIES OF ELEMENTARY PARTICLES. Ruehl, W. (CERN, Geneva). pp 49-68 of Physikertagung 1965 Frankfurt (M)-Hoechst, Okt. 4-9. Plenarvortraege. Stuttgart, B. G. Teubner Verlagsgesellschaft mbH, 1965. (In German).

For lead abstract see CONF-651030-(Vol.2) in report number index.

A review is given of the nonrelativistic and relativistic SU(6) theory. Current algebra is considered. A bibliography of works on the SU(6) theories is included. (J.S.R.)

28028 DEVELOPMENTS OF THE LATER RELATIVISTIC QUANTUM FIELD THEORY. Kaellen, Gunnar (Univ., Lund, Sweden). pp 246-70 of Physikertagung 1965 Frankfurt (M)-Hoechst, Okt. 4-9. Plenarvortraege. Stuttgart, B. G. Teubner Verlagsgesellschaft mbH, 1965. (In German).

For lead abstract see CONF-651030-(Vol.2) in report number index.

A review is given of the development of the relativistic quantum mechanics directed specifically to the physical scientist who is not a specialist in this area. (J.S.R.)

28029 FUNDAMENTALS OF THE DYNAMICS IN NONLINEAR FIELD THEORY WITH NONCANONICAL RELATIVISTIC HEISENBERG QUANTIZATION. Stumpf, H. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). pp 59-65 of Physikertagung 1965 Frankfurt (M)-Hoechst, Okt. 4-9. Vorabdrucke von Kurzfassungen der Fachberichte. Stuttgart, B. G. Teubner Verlagsgesellschaft mbH, 1965. (In German).

For lead abstract see CONF-651030-(Vol.1) in report number index.

A noncanonical quantization was proposed by Heisenberg for the regularization of quantized nonlinear spinor equations. A quantum mechanical example was used to show the consequences of the noncanonical quantization for the representation of observables. From these considerations it follows that for the calculation of eigenvalues for observables the conventional Schroedinger equation cannot be used but new calculation methods must be applied. The presently

used method is the Tamm-Dancoff calculation. The Tamm-Dancoff method was based originally on the unique form of the inharmonic oscillators. The multi time form of inharmonic oscillators was discussed and the structural analogy to the equations of field theory was shown. The consequences of this analogy for the establishment of noncanonical quantized spinor theory was explained and it was shown how the special relativistic noncanonical Heisenberg quantization is derived. (tr-auth)

28030 STRONG INTERACTIONS AT HIGH ENERGIES. Soeding, P. (Institut fuer Experimentalphysik, Hamburg). pp 180-7 of Physikertagung 1965 Frankfurt (M)-Hoechst, Okt. 4-9. Vorabdrucke von Kurzfassungen der Fachberichte. Stuttgart, B. G. Teubner Verlagsgesellschaft mbH, 1965. (In German).

For lead abstract see CONF-651030-(Vol.1) in report number index.

The high-energy behavior of the scattering of strongly interacting particles was discussed, especially the following points: the total interaction cross section as a function of the energy, Pomeranchuk theorem, diffraction scattering, real part of the amplitude in the forward direction, elastic scattering with large momentum transfer, and the behavior of the charge-exchange scattering. A review of the experimentally found particles is given and the data were compared with theoretical predictions and models. (tr-auth)

28031 SECOND QUANTIZATION OF AN ARBITRARY OPERATOR. Kobe, D. H. (Uppsala Univ.). Proc. Phys. Soc., 88: 9-12(May 1966).

The representation of an arbitrary operator in second quantization is obtained for both fermion and boson systems by using the isomorphism between second quantization and a graded configuration space. (auth)

28032 SEMI-CLASSICAL SCATTERING PHASE SHIFTS IN THE PRESENCE OF METASTABLE STATES. Berry, M. V. (Univ. of Bristol, Eng.). Proc. Phys. Soc. (London), 88: 285-92(June 1966).

In recent paper, Curtiss and Powers claim to have shown that the phase shift η_l for the case when the effective potential presents three turning points, contains in the classical limit a contribution from the classically inaccessible potential well between the inner two turning points, but is independent of the form of the barrier between the outer two turning points. It is shown that what Curtiss and Powers calculated is the semi-classical form of the average of η_l over a small range of energies. If the correct semi-classical η_l is used, the contribution of classically inaccessible regions to the averages of observable quantities such as cross sections vanishes in the classical limit, as one would expect. (auth)

28033 TWO EXAMPLES OF COVARIANT THEORIES WITH INTERNAL SYMMETRIES INVOLVING SPIN. Barut, A. O.; Budini, P.; Fronsdal, C. (International Centre for Theoretical Physics, Trieste, Italy). Proc. Roy. Soc. (London), Ser. A, 291: No. 1424, 106-12(Mar. 29, 966). 1966). (IC-65/34).

Although there are severe limitations on the combination of Poincaré group and an internal group it is shown in two examples how such a consistent combination can be achieved. The first example deals with the Bethe-Salpeter equation of two interacting scalar particles via a mass-zero scalar particle, and neglects consistently the spin-orbit coupling. The second example is the hydrogen atom where a noncompact group is used to describe all states of the system in the limit of energies being equal. (auth)

28034 ELECTROMAGNETIC PROPERTIES OF HADRONS BASED ON SU_6 SYMMETRY. Wess, Julius E. (Univ. of Vienna). pp 134-5 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

Some predictions of SU(6) symmetry for the transition moments and form factors of baryons and mesons are outlined. (D.C.W.)

28035 CABIBBO ANGLE AND RENORMALIZATION OF THE $\Delta S = 1$ AXIAL-VECTOR CURRENT. Sato, Akira; Sasaki, Shosuke (Osaka Univ.). Progr. Theoret. Phys. (Kyoto), 35: 335-7(Feb. 1966).

The current generated algebra of SU(3) × SU(3) and the partially conserved current are used to show that the $\Delta S = 1$ axial-vector current is suppressed as strongly in the bare current as in the effective matrix element. (J.F.P.)

28036 DISPERSION APPROACH TO THE PROBLEM OF SCATTERING. Malchenko, V. I. (Dnepropetrovsk State Univ., USSR). Ukr. Fiz. Zh., 11: 245-52(Mar. 1966). (In Ukrainian).

A theory of potential scattering of relativistic spinless particles is developed, based on the analyticity of the scattering amplitude with respect to variables s, t, and g, and on the unitarity condition. (auth)

28037 TEORETICHESKAYA FIZIKA I FIZIKA ELEMENTARNYKH CHASTITS. SLABOE VZAIMODEISTVIE ELEMENTARNYKH CHASTITS. (Theoretical Physics and Physics of Elementary Particles. Weak Interactions of Elementary Particles). Moscow, Akademiya Nauk SSSR Institut Nauchnoi Informatsii Itogi Nauki, 1965. 195p.

Two articles, consisting of surveys of the present state of the theory of weak interactions and of the literature on weak interactions, are included. Separate abstracts were prepared for both. (M.J.T.)

For abstracts of individual papers see: 28038 and 28039.

28038 WEAK INTERACTIONS AND UNITARY SYMMETRY. Okun, L. B. pp 3-60 of Teoreticheskaya Fizika i Fizika Elementarnykh Chastits. Slaboe Vzaimodeistvie Elementarnykh Chastits. Moscow, Akademiya Nauk SSSR Institut Nauchnoi Informatsii Itogi Nauki, 1965. (In Russian).

The present state of the theory of weak interactions of elementary particles is surveyed. A summary is given of the experimental proof for the hypothesis of the universal V-A interaction, which determines the kinematic properties of weak processes, and the hypothesis of the minimum model, which determines the iosotopic properties of these processes. The study of symmetries higher than isotopic is introduced, and SU(3) symmetry and its manifestations in weak interactions of hadrons are examined. (M.J.T.)

28039 WEAK INTERACTIONS OF ELEMENTARY PARTICLES. Bibliographical Review for 1961-1963 and the First Half of 1964. Tsukerman, I. S. pp 61-194 of Teoreticheskaya Fizika i Fizika Elementarnykh Chastits. Slaboe Vzaimodeistvie Elementarnykh Chastits. Moscow, Akademiya Nauk SSSR Institut Nauchnoi Informatsii Itogi Nauki, 1965. (In Russian).

A bibliography of literature on weak interactions, covering the period from Jan. 1, 1961, to June 30, 1964, is presented. An author index, a list of more than 1300 references, and a table of contents, giving references separately to experimental and theoretical works and to the various processes studied, are included. (M.J.T.)

Fluid Physics and Thermodynamics

See also Plasma Physics and Thermonuclear Processes

Refer also to abstracts 28169 and 28619.

28040 (AD-609534) SOLUTIONS OF THE MAGNETO-FLUIDDYNAMIC BOUNDARY-LAYER EQUATIONS FOR A FLAT PLATE WITH A MOVING TRANSVERSE MAGNETIC FIELD SOURCE OR CROSSED ELECTRIC FIELD IN THE SPANWISE DIRECTION. Jaffe, N. A. (Douglas Aircraft Co., Inc., Long Beach, Calif.). Nov. 1, 1964. 50p. (LB-31693). CFSTI $2.00 cy, $0.50 mn.

The effects of a transverse magnetic field on velocity profiles in the boundary layer of a conducting fluid are investigated. A numerical technique is used to obtain solutions of the combination of continuity and momentum

equations for flow of an incompressible fluid over a flat plate. Both variable conductivity and constant conductivity are studied. In the former case a magnetic-field velocity ratio is defined and its effect on velocity profiles is examined. This parameter arises either from a source of the magnetic field moving with respect to the surface or an applied electric field parallel to the surface in the spanwise direction. Velocity profiles and corresponding skin friction, net drag, displacement thickness, and momentum thickness are given for magnetic-interaction parameters over a range from 0 to 0.6 and magnetic-field velocity ratios ranging from 0 to 50. It is shown that when the magnetic-field velocity ratio is zero, the magnetic effect will decrease skin friction; increase displacement thickness, momentum thickness, and net drag; and destabilize the boundary layer. These effects are reversed when the magnetic-field velocity ratio is greater than or equal to unity. Nonsimilarity effects are studied by solving the equations when the magnetic-interaction parameter is allowed to increase linearly with distance from the leading edge. The results show that for given values of the magnetic-interaction parameter and magnetic-field velocity ratio the effects are greater for a similarity solution than for a nonsimilarity solution; however, the similarity solutions are a fair approximation of the nonsimilarity except where the boundary layer is near separation, and here there is noticeable divergence. Where applicable, the results are compared with a previously developed series methods. The two methods, which both converge to the Blasi solution as the magnetic-interaction parameter goes to zero, show increasing disagreement with increasing magnetic-interaction parameter. (auth)

28041 (CLM-R-56) CONDITIONS AT EQUILIBRIUM BEHIND STRONG SHOCK WAVES IN HYDROGEN. Fisher, D. L. (Culham Lab., United Kingdom Atomic Energy Authority, Abingdon (England)). Jan. 1966. 14p. Dep. mn. BIS $0.50. HMSO 2s. 6d.

The equilibrium conditions behind strong shock waves traveling into hydrogen gas at ambient laboratory temperatures and at a range of initial pressures, values of magnetic field and fractions of ionization were determined by solving the Rankine-Hugoniot equations coupled with the Saha equation. (auth)

28042 (RT-FI-(65)-61) THERMALIZATION TIMES OF LOW-ENERGY ELECTRONS IN RARE GASES. Braglia, G. L.; de'Munari, G. M.; Mambriani, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). Dec. 1965. 13p. Dep. mn.

The thermalization time of electrons is given in helium, neon, argon, krypton and xenon, as a function of the initial electron energy and of the gas temperature. This time was calculated by numerical integration of the slowing-down equation which takes into account only the elastic collisions of the electrons. The best available values of the momentum-transfer cross sections were used. (auth)

28043 (UCRL-14891-T) PREDICTION OF TRANSPORT PROPERTIES OF DENSE GASES AND LIQUIDS. Alder, B. J. (Lawrence Radiation Lab., Univ. of California, Livermore). May 11, 1966. Contract W-7405-eng-48. 30p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

An accurate and simple theory of transport properties was developed on the basis of the van der Waals concept of a dense fluid. It was shown that calculated values for the transport coefficients of the rare gases at temperatures and densities greater than the respective critical ones agree to within about 10% with the experimental results in both absolute value and temperature dependence, without invoking an activation barrier. In this a priori theory, the cross section, that is the hard sphere diameter, is determined as a function of temperature from the available equilibrium data, within the framework of the van der Waals theory. Evidence in favor of the van der Waals model and against the activation model was also found in a study of the free path distribution by molecular dynamics computer calculations. This evidence consists of a monotonic free path distribution without a peak near an intermolecular distance at all densities and temperatures for square-well molecules. Furthermore, the free path distribution as well as the radial distribution function are nearly temperature independent at a given density. Finally, there were found to be more hard core encounters than soft collisions even at liquid densities and low temperatures. (auth)

28044 DERIVATION OF GENERAL MAGNETOHYDRODYNAMIC BOUNDARY LAYER EQUATIONS WITH EXPLICIT SOLUTIONS FOR THE LONGITUDINAL FIELD. Jungclaus, G. (Technische Hochschule, Karlsruhe, Ger.). Acta Mech., 1: 265-84(1965). (In German).

General magnetohydrodynamic boundary layer equations are established for plane, stationary, incompressible, laminar flow. From these follow, according to the magnitude of the parameters (Reynolds number R, magnetic Reynolds number R_m and Alfvén number β) the previously treated equations for the transversal and the longitudinal field and a number of additional equations. It is shown, that the assumptions – R is large and the thickness of the boundary layer is inversely proportional to the square root of R – are too restrictive. For a longitudinal field, with $R_m \approx R$ and $\beta \gg 1$, the thickness of the boundary layer is inversely proportional to the fourth root of R. In this case it is possible to give explicit solutions for the flow past a plate and the free jet. (auth)

28045 DUCT-FLOW OF CONDUCTING FLUIDS UNDER ARBITRARILY ORIENTED APPLIED MAGNETIC FIELDS. Eraslan, Arsev H. (Univ. of Tennessee Space Inst., Tullahoma). AIAA (Amer. Inst. Aeron. Astronaut.) J., 4: 620-6(Apr. 1966).

The steady, fully developed, laminar duct flow of a viscous, electrically conducting fluid is investigated under uniform, arbitrarily oriented, externally applied magnetic fields. The governing differential equations are developed for the general problem, and a set of transformations are given for uncoupling the system. The general technique is applied to the problem of a rectangular duct with nonconducting walls, and exact solutions are obtained by the method of finite Fourier transformation. The effects of the orientation of the applied magnetic field on the hydromagnetic characteristics of the flow are discussed for the particular problem. (auth)

28046 QUANTUM EFFECTS IN MOLECULAR SCATTERING. Monchick, L. (Johns Hopkins Univ., Silver Spring, Md.). APL (Appl. Phys. Lab.) Tech. Dig., 5: 11-14(Jan.-Feb. 1966).

Some qualitative features of the scattering cross sections are discussed, as well as the influence of quantum effects on the macroscopic transport properties of gases. It is shown that the transport properties of ^{3}He and ^{4}He can be calculated with the same potential function as was found experimentally at high temperatures if suitable account is taken of quantum effects. Classical theory, as expected, failed. In a mixture of two experimentally distinguishable atoms, the binary diffusion coefficient is almost wholly a function of the interaction between the unlike atoms. Measurements in ^{3}He-^{4}He mixtures and spin-diffusion measurements in ^{3}He allow a test of the theory. A comparison of the quantum and classical calculations for ^{3}He-^{4}He with the experimental results is presented. (BBB)

28047 CONTINUOUS-WAVE SUBMILLIMETER OSCILLATION IN H_2O, D_2O, AND CH_3CN. Mueller, Walter M.; Flesher, Gail T. (General Motors Corp., Santa Barbara, Calif.). Appl. Phys. Lett., 8: 217-18(May 1, 1966).

Wavelengths were obtained for continuous wave submillimeter laser action of flowing H_2O, D_2O, and CH_3CN in a d-c discharge. (B.G.D.)

28048 APPROXIMATE METHOD FOR DETERMINING WHEN ANY GAS IS COLLISION-DOMINATED. Sampson, Douglas H. (General Electric Co., Valley Forge, Pa.). Astrophys. J., 144: 96-102(Apr. 1966).

With the use of the Seaton formula for the collisional excitation and ionization cross sections, a simple equation is obtained giving the relation between the electron tem-

perature T_e, electron density N_e, and the ionization energy I_i' required for a gas to be collision dominated. (Here I' refers to the most tightly bound level of importance for a given N_e and T_e.) Then, with the use of an approximate equation expressing I_i' in terms of T_e and N_e, an approximate general equation giving the relation between T_e and N_e necessary for all elements to be collision dominated is obtained. It is seen that at high temperatures very high electron densities are required for high Z elements to be collision dominated. (auth)

28049 EMPIRICAL EQUATION OF TEMPERATURE DEPENDENCE OF HEAVY WATER DENSITY. Kravchenko, V. S. At. Energ. (USSR), 20: 168(Feb. 1966). (In Russian).

An empirical equation is presented for the temperature dependence of the density of heavy water. (G.O.Y.)

28050 A CONTRIBUTION TO THE THEORY OF IONIZATION WAVES IN THE POSITIVE COLUMN OF A GLOW DISCHARGE. Kolacek, Karel (Charles Univ., Prague). Cesk. Cas. Fys., 16: 221-7(1966). (In Czech).

The energy averaging of the Boltzmann-Vlasov kinetic equation is performed for small discharge currents in a one-dimensional approximation on the assumption that the velocity distribution of the electrons is near to the Maxwell distribution. (auth)

28051 UNSTEADY CONVECTIVE MAGNETOHYDRODYNAMIC CHANNEL FLOW. Singer, Ralph M. (Argonne National Lab., Ill.). Chem. Eng. Progr., Symp. Ser., 61: No. 59, 36-49(1965).

The unsteady, combined free and forced convective flow of an electrically conducting fluid through a transverse magnetic field is analyzed. Allowing the channel wall temperature to vary linearly with the axial coordinate of the duct allows a fully developed flow situation that linearizes the governing equations and permits an analytical solution. The unsteadiness may occur because of variations in the axial pressure gradient, wall temperature, or internal energy generation rate. The effects of the thermal and magnetic Prandtl numbers, the Hartmann number, the Rayleigh number, and internal energy generation upon the flow and heat transfer are studied. Oscillatory behavior is observed for large values of Ra and M and for Pr near unity, and the length of the transient period is found to depend strongly upon these parameters. (auth)

28052 STUDY OF THE EFFECTS OF THE EXTREMITIES ON THE FLOW IN MAGNETOHYDRODYNAMIC JETS. Nguyen-Ngoc-Tran. Compt. Rend., Ser. A., 262: 583-6(Mar. 7, 1966). (In French).

The effects of extremities on the velocity field and on the electric and magnetic fields of a weakly conducting fluid flow in a magnetohydrodynamic jet are studied. The analogical calculation is used to resolve the problems encountered. (tr-auth)

28053 STUDY OF THE EFFECTS OF EXTREMITIES AND OF NONUNIFORM AND ANISOTROPIC ELECTRIC CONDUCTIVITY ON THE FLOW IN MAGNETOHYDRODYNAMIC JETS. Nguyen-Ngoc-Tran (CNRS, Chatillon, France). Compt. Rend., Ser. A. 262: 649-52(Mar. 14, 1966). (In French).

The effects of extremities and of nonuniform anisotropic electric conductivity on the flow in magnetohydrodynamic jets were studied in the approximation of the $(R_M)^0$ order. Analogical calculations were used to determine the electric potential $\varphi^0(x,y)$, the only unknown of the problem. (tr-auth)

28054 BOLTZMANN EQUATION IN RELATIVITY. Vignon, Bernard (Faculte des Sciences, Dijon, France). Compt. Rend., Ser. A, 262: 795-8(Mar. 28, 1966). (In French).

The Boltzmann equation was established in the most general hypotheses by remarking that this equation should represent the following property: in the absence of collisions, the Lie derivative of the f_η expression along the trajectories in the space of states should be 0 (the molecules do not leave trajectory tubes). By utilizing normal coordinates the macroscopic equations of the fluid in the absence of the external field are obtained by integrations in the thread at the point $\underline{x}$. (tr-auth)

28055 INTRODUCING THE BOLTZMANN DISTRIBUTION. Grassie, A. D. C. (Univ. of Sussex, Brighton, Eng.); Spice, J. E.; Gerrard, A. Contemp. Phys., 7: 81-102(Dec. 1965).

The presentation of the Boltzmann distribution formula in sixth-form teaching is discussed from different viewpoints. R. P. Feynman's approach is considered, in terms of competing kinetic and potential energies. A simple inductive statistical argument following R. W. Gurney is given. A rigorous derivation with relatively elementary mathematics of the Maxwell-Boltzmann formula for translational kinetic energy is explained. (auth)

28056 PREDICTION OF TWO-PHASE ANNULAR FLOW WITH LIQUID ENTRAINMENT. Levy, S. (General Electric Co., San Jose, Calif.). Contract AT(04-3)-189. Int. J. Heat Mass Transfer, 9: 171-88(Mar. 1966).

An analytical prediction of two-phase annular flow with liquid entrainment is presented. The solution is obtained by considering the momentum and mass-transfer components of the interfacial shear and showing that the momentum term is dominant within the liquid film, while the mass-transfer term is the important component within the gas core. An expression is derived for the interfacial shear in terms of liquid-film thickness, and this equation is used: To correlate the available CISE film thickness data in circular pipes with two-phase flow of water or alcohol and argon or nitrogen at various pressures. To predict liquid film thickness, liquid film flow rate, and liquid entrainment in the gas core. Typical results are presented for steam-water mixtures flowing in circular pipes at high pressure. To compare the predicted values of liquid film thickness and flow rate with reported measurements in upwards, downwards and horizontal flow. (auth)

28057 RESISTANCE TO MOTION AND HEAT EXCHANGE IN A TUBE DURING TURBULENT FLOW OF AN ELECTRICALLY CONDUCTING LIQUID IN THE PRESENCE OF A TRANSVERSE MAGNETIC FIELD. Novikov, I. I. Izmeritel. Tekh., No. 2, 33-4(Feb. 1966). (In Russian).

Expressions were derived for the local friction and heat transfer coefficients with turbulent flow of an electrically conducting liquid in a transverse magnetic field. The friction factor c with stabilized flow is given by the following relation: $c = a'\,(Ha/Re)^p$. Here p is equal to $2m/(1+m)$; Re is the Reynolds number, and Ha is the Hartman number. This relation holds for strong magnetic fields whose energy density is significantly larger than the kinetic energy of a unit volume of liquid. With $Ha^2/Re < 1$, the magnetic energy density is comparable or less than the kinetic energy density, and a somewhat more complicated expression is obtained for the friction factor. An expression is also given for the Nusselt number in terms of the Reynolds number, the Prandtl number, and the Hartman number. (TTT).

28058 ESTIMATE OF DRAG AND HEAT TRANSFER COEFFICIENTS DURING ELECTROCONDUCTING FLUID FLOW IN A MAGNETIC FIELD. Novikov, I. I. Izmeritel. Tekh., No. 12, 24-8(Dec. 1965). (In Russian).

The flow of an electrically conducting fluid in a magnetic field in analyzed, finding equations for the drag coefficient and the coefficient of heat exchange between the fluid and the walls as functions of the flow conditions. The very simple case of the stationary flow of a two-dimensional parallel current of an electrically conducting fluid around a thin disk in a magnetic field is examined. Equations are found for the coefficients of drag and heat transfer for laminar and turbulent flow in a transverse magnetic field, for low values of the magnetic Reynolds number; in addition, the formulas for heat transfer are valid only at high magnetic-field intensities, where the Hartmann number is large with respect to the boundary-layer thickness. (M.J.T.)

28059 COUPLED ELECTRON-HOLE CASCADE IN A FREE ELECTRON GAS. Ritchie, R. H. (Oak Ridge

National Lab., Tenn.). J. Appl. Phys., 37: 2276-8 (May 1966). (ORNL-P-1693).

The coupled electron-hole cascade in an electron gas is described by a space- and angle-independent transport equation. Analytic cross sections employed for the various processes are appropriate to a high density electron gas and for low to moderate excitation energies. The solution of the integral transport equation may be expressed in analytic form. It is found that the cascade process results in the accumulation of extremely large numbers of electrons and holes close to the Fermi surface. (auth)

28060 VELOCITY MEASUREMENT OF A MAGNETICALLY INDUCED ARC WIND. Weichel, Hugo (Air Force Weapons Lab., Kirtland AFB, N. Mex.). J. Appl. Phys., 37: 2317-19(May 1966).

In agreement with earlier observations, an arc discharge in a transverse magnetic field was found to be always accompanied by a high-velocity gas flow in the $\vec{J} \times \vec{B}$ direction. By means of a temperature probe and a calibrated dragmeter the velocity of this arc wind was measured for several magnetic fields and various distances above the arc path. The maximum velocity was found to be between 3.5×10^3 and 7.0×10^3 cm/sec for magnetic fields of 520 and 2000 G, respectively. (auth)

28061 FREE MOLECULAR CONDUCTANCE OF A CYLINDRICAL TUBE WITH WALL SORPTION. Smith, Craig G.; Lewin, Gerhard (Princeton Univ., N. J.). J. Vac. Sci. Technol., 3: 92-5(May-June 1965).

A Monte Carlo method was used to calculate the probability that a molecule passes through a cylindrical tube with wall sorption. This probability is presented as a function of the ratio of length to radius and the sticking coefficient s of the wall. For $s = 0$, the results confirm those of Clausing for the conductance of a tube of finite length. For $s \neq 0$, wall pumping can greatly reduce the flow of gas, even for very small values of s. The backscattering, total flux retained by the wall, and its distribution along the tubes also are presented. Finally, the collimation of the emerging beam is investigated. (auth)

28062 NONSTATIONARY, ONE-DIMENSIONAL PROBLEM IN MAGNETOGASDYNAMICS. RIEMANN WAVES. Saltanov, N. V.; Tkalich, V. S. Magnit. Gidrodin., No. 4, 35-40(1965).

Introducing appropriate transformations, the relativistic equations of motion and continuity and equation of induction are rewritten to coincide with Sedov's equations in Rudnev's form, with accuracy up to the symbols. This permits use of known stationary solutions in the analysis of nonstationary problems and vice versa. Conditions for linearizing the problem are also indicated. In the process of linearizing the problem, the Riemann waves are obtained. By imposing further restrictions on the physical variables the problem is reduced to a nonrelativistic case which emphasizes the two extreme cases of very long and very short wave. (ATD)

28063 VARIATIONAL PRINCIPLES IN MAGNETO-HYDRO- AND AERODYNAMICS. Kozyrenko, V. E. Magnit. Gidrodin., No. 4, 41-4(1965). (In Russian).

Skobelkin's application of variational principles to gas dynamics is generalized to describe magnetohydro- and aerodynamic stationary processes. As a first step, the procedure employed solves the original magnetohydrodynamic equations together with the generalized Ohm's law. Next, the general solution obtained is used to transform the set of equations into a Pfaffian form. The coefficients are evaluated using variational principles. The resulting form of these coefficients shows that for incompressible inviscid fluid the variational integral is stationary. An analogous approach is taken in a discussion of the magnetohydrodynamic problem where dissipations are neglected and the compression is given by an additional restriction. This approach also leads to a generalized Bernoulli's equation. (ATD)

28064 FLOW OF ELECTROLYTE IN A CIRCULAR TUBE IN THE PRESENCE OF A MAGNETIC FIELD. Parfenov, B. V.; Regirer, S. A. Magnit. Gidrodin., No. 4, 50-2 (1965).

The electrolyte (a solution of 10% hydrochloric acid in water) was circulated through round tubes of varying diameter (from .35 to 3.0 cm). Both glass and plastic were used as tube material; the other parts of the experimental apparatus were also made of nonconducting materials. The flow parameters are given in terms of Hartmann and Reynolds numbers for tubes with smooth and rough internal surfaces. It was noted that even in absence of the magnetic field, parasite potentials developed across measuring electrodes, thus complicating the measurement procedures. All measurements of the induced potential differences arising from the presence of the magnetic field were conducted at laminar flow and transitions to the turbulent flows. No noticeable difference in the accuracy due to change from laminar to turbulent flow was observed. Results of experiments agree with the theoretical formula derived by R. R. Gold (J. Fluid Mech., 1962, 13, 4, 505) for an infinitely long tube. (ATD)

28065 SELF-INDUCED MAGNETIC FIELD IN ONE-DIMENSIONAL FLOW OF AN ELECTRICALLY CONDUCTING FLUID. Yantovskii, E. I. Magnit. Gidrodin., No. 4, 53-6(1965). (In Russian).

A conducting fluid flowing in a narrow channel with the applied magnetic field perpendicular to the flow is described with the aid of the usual magnetohydrodynamic equations. The equations employed take account of the induced magnetic field which is significant when fluid conductivity is sufficiently high. Two cases, namely, flows with constant velocity and flows with constant pressure are examined in detail. In both cases the fluid energy is transformed into electric energy which is extracted in an external load. In the constant velocity case, it is the potential energy which is transformed. In the constant pressure case, the kinetic energy of the fluid is transformed. The induced magnetic field is plotted for both cases as a function of the channel position. Additional conditions allowing the acceleration of the flow are also briefly considered. (ATD)

28066 ON THE POSSIBILITY OF ACCOUNTING FOR MHD EFFECTS IN THE LAMINAR MOTION OF LIQUID METAL DROP IN A DIELECTRIC MEDIUM. Zambran, A. P. Magnit. Gidrodin., No. 4, 57-60(1965). (In Russian).

The constant motion of a liquid metal drop in a magnetic field parallel to the direction of motion is considered. The differential equations describing the motion are derived together with the appropriate boundary condition. The dissipation of kinetic energy through Joule heating is derived from dimensional analysis. The decelerating force due to the presence of the magnetic field is obtained for the case where Hartmann's number is much smaller than unity. In cases where, in addition to the above condition, the Reynolds number is also less than unity, viscosity coefficients are derived. The presence of the magnetic field is shown to stabilize the motion and to increase the time necessary to distort and deform the drop. (ATD)

28067 PLANE LAMINAR FLOW OF A NON-NEWTONIAN LIQUID IN A TRANSVERSE MAGNETIC FIELD. Martinson, L. K.; Pavlov, K. B. Magnit. Gidrodin., No. 4, 61-6(1965). (In Russian).

Two-dimensional laminar magnetohydrodynamic flows of a class of non-Newtonian liquids (so-called viscous-plastic flows) are studied. This flow is considered to be in a shallow flat channel with nonconducting walls. A uniform magnetic field is applied normal to the flow. The flow is caused by an applied pressure and the resulting pressure gradient in the flow direction. The equations describing the flow are solved to obtain the velocity profile. The motion of a central core of the fluid, behaving as a solid body is also derived on the pressure gradient and on the value of the magnetic field, as well as on the operating regime of the flow. The conditions which must be satisfied in order for the flow to become Newtonian are determined and their significance is discussed. The

difference between the two kinds of flows is due mainly to the presence of the solid nucleus. (ATD)

28068 SEMICONFINED CONDUCTING FLUID JET. Vulis, L. A.; Dzhayzashtin, K. E. Magnit. Gidrodin., No. 4, 67-74(1965). (In Russian).

The stationary problem of incompressible viscous conducting liquid moving as a stream along a flat surface is considered. The problem considers a flow in a magnetic field normal to the surface which constricts the flow to a semibounded space. The magnetic field value restricts the Reynolds number values to much less than unity. The usual equations of motion are solved by use of similarity transformations and iterative approximations where the zero order solution is that for the nonconducting fluid. It is shown that the velocity profile is given quite accurately by a single iteration. The solutions are plotted for several values of the parameter which determines the strength of the magnetic interaction. This problem is further extended by the inclusion of heat diffusion. Solutions for three different sets of boundary conditions are given. The resulting temperature profiles are plotted in terms of several sets of appropriate parameters. (ATD)

28069 CONDUCTING FLUID FLOW IN A CONSTANT MAGNETIC FIELD WITH A POWER FUNCTION OF THE VELOCITY PROFILE ALONG THE GAP. Tolmach, I. M. Magnit, Gidrodin., No. 4, 75-9(1965). (In Russian).

Two dimensional turbulent flow of a liquid with constant conductivity and with constant applied magnetic field is considered. The flow profile is assumed to have power-law dependence, where the exponent is a function of hydraulic and magnetic parameters. The functional dependence of these parameters is determined empirically. The special case of a vanishing magnetic field reduces the exponent solely to a function of the Reynolds number. The imposition of a magnetic field preserves the form of the velocity profile, requiring only a change in the exponent. The form of the current density is derived with the help of a velocity profile equation and permits the calculation of Joule heating. The efficiency of the system is computed for several values of the exponent for cases where the system is operated in the generator regime. The empirically derived exponent is used to evaluate the coefficient of hydraulic resistance. This value is shown to agree with the experimental data of other studies. (ATD)

28070 THE BEHAVIOR OF A STREAM IN A CHANNEL WITH NONCONDUCTING WALLS IN A TRANSVERSE MAGNETIC FIELD. Branover, G. G.; Shcherbinin, E. V. Magnit. Gidrodin., No. 4, 154(1965). (In Russian).

Plane streams of mercury passed into a rectangular channel with insulated walls were found to exhibit unusual behavior with the imposition of a transverse magnetic field. The initial plane stream ceases almost entirely after a very short distance and the entire flow is concentrated in two narrow layers which cling to the walls of the channel and are parallel to the magnetic field. This flow structure is maintained over a considerable distance. (ATD)

28071 MAGNETIC VISCOSITY AND THE STABILITY OF SUPERPOSED FLUIDS IN A MAGNETIC FIELD. Singh, Surindar; Hans, Harikrishan (Univ. of Delhi). Nucl. Fusion, 6: 6-8(Mar. 1966).

The effect of magnetic viscosity is investigated in two simple stability problems—Rayleigh-Taylor instability and Kelvin-Helmholtz instability of superposed fluids. In the Rayleigh-Taylor instability, perturbations perpendicular to the magnetic field are suppressed. In the Kelvin-Helmholtz instability, a magnetic field transverse to the direction of streaming velocities in general opposes the development of instability. (auth)

28072 HYDROMAGNETIC SHOCK FRONTS WITH COLLISIONLESS DISSIPATION. Bardotti, G.; Cavaliere, A.; Engelmann, F. (EURATOM-CNEN, Rome). Nucl. Fusion, 6: 46-55(Mar. 1966).

The structure of a hydromagnetic shock front wherein an electrostatic turbulence continuously develops from a two-stream instability, is investigated to aim at orders of magnitude for the width of the front, the heating of electrons and ions, and the magnitude of excitation of fluctuations. Use is made of a stationary macroscopic model that includes two phenomenological parameters. The meaning of these is examined on the basis of a microscopic theory of weak turbulence; an argument is put forward which shows that an appreciable heating of electrons can be consistent with such a regime. Conditions entailing a turbulent shock are given. (auth)

28073 TRANSVERSE MOMENTUM TRANSPORT IN VISCOUS FLOW OF DIATOMIC GASES IN A MAGNETIC FIELD. Korving, J.; Hulsman, H.; Knaap, H. F. P.; Beenakker, J. J. M. (Kamerlingh Onnes Lab., Leiden). Phys. Lett., 21: 5-7(Apr. 15, 1966).

It is proved experimentally that, in a magnetic field, transverse momentum transport occurs in viscous flow of diatomic molecules. The experimental results agree with theoretical calculations. The sign of the molecular gyromagnetic ratio can be determined. (auth)

28074 NONPERTURBATIVE PROOF OF SOME RESULTS IN CLASSICAL NONEQUILIBRIUM STATISTICAL MECHANICS. Aronson, Raphael (New York Univ., N. Y.). Phys. Rev., 145: 46-54(May 6, 1966).

Some results of interest in classical nonequilibrium statistical mechanics, previously proved to all orders in the interaction, are proved without recourse to perturbation expansions, making it possible to avoid convergence questions. One theorem so proved is that when the interaction is switched on slowly, a Maxwellian distribution goes into the canonical distribution at the same temperature. The two steps in the Prigogine theory of the approach to equilibrium that originally depended on a perturbation proof are also demonstrated nonperturbatively. Lastly, the statement that in equilibrium cluster expansions in the density there are no articulation points in the graphs contributing to the reduced distributions is proved from a time-dependent point of view. (auth)

28075 EXCITATION SPECTRUM OF THE BOSE LIQUID. Byckling, Eero (Inst. of Tech., Otaniemi, Finland). Phys. Rev., 145: 71-5(May 6, 1966).

The assumptions and predictions of the Brueckner-Sawada method (including recent refinements) for the derivation of the excitation spectrum of the high-density boson system are examined using Green-function techniques and a new method of solving the scattering-matrix equation. In the case of the real interaction potential of ^{4}He atoms, the spectrum obtained in the approximation has the correct form but the depletion has a meaningless value. It is pointed out that a probable cause of discrepancies is inconsistent omission of certain self-energy terms. (auth)

28076 QUANTUM-MECHANICAL, MICROSCOPIC BROWNIAN MOTION. McKenna, J.; Frisch, H. L. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 145: 93-110(May 6, 1966).

Recently, the Fokker-Planck (F-P) equation, satisfied by the phase-space distribution function of a Brownian (B) particle, was derived from the Liouville equation, satisfied by the phase-space distribution function of the composite system, B particle plus fluid. From a strictly quantum-mechanical formulation of the problem, using a density-matrix description of the composite system, it is shown that in an appropriate classical limit the F-P equation results. To lowest order in $\hbar$, the technique gives the same expression for the friction coefficient obtained earlier from the Liouville equation. In principle it yields corrections to the F-P equation to all order in $\hbar$. It is shown that for a uniform fluid, the quantum corrections to the F-P equation to first order in $\hbar$ appear only as a shift in the friction coefficient. If the classical friction coefficient ζ_0 is replaced by $\zeta_0 + \hbar\zeta_1$, with an appropriate ζ_1, then the F-P equation is given correctly to order $\hbar$. There is a difference in the mass dependence of ζ_0 and ζ_1 which suggests the existence of an isotope effect in the mobility of a particle moving through a quantum fluid.

The technique employed in the derivation is to consider the expectation value of the density matrix of the system in a state in which the position and momentum of the particles are known with maximum accuracy (Kennard packet). This expectation value μ is an appropriate, positive, semiclassical phase-space distribution function. An appropriate equation is derived for μ, which to lowest order in $\hbar$ is the Liouville equation. The remainder of the derivation is similar to the derivation in the classical case (a suitable projection technique is used). (auth)

28077 VORTEX RINGS IN A BOSE FLUID. Amit, D.; Gross, E. P. (Brandeis Univ., Waltham, Mass.). Phys. Rev., 145: 130-6(May 6, 1966).

Vortex rings are considered as flow patterns of a phenomenological Hartree-type fluid with parameters fitted to the observed phonon-roton spectrum. The basis of the calculations is variational, and density patterns which are constant except in vortex cores are employed. The energy of vortex lines and rings is expressed in terms of a core radius c, defined as the distance from the singular line of the vortex to the point of half the asymptotic density. The core size is determined by minimizing the energy and is found to be independent of the ring radius when the latter is larger than ten times the core radius. Comparing the results with the data of Rayfield and Reif, one finds c = 1.7 Å, while the phenomenological model yields half this value. The critical velocity associated with ring formation in a channel is considered following the lines of Fetter's earlier calculation. In the calculation it is possible to incorporate the Fineman-Chase analysis of channel wall effects. Agreement with experiment is considerably improved. (auth)

28078 ANALYSIS OF A MODEL EXHIBITING CONDENSATION WITH APPLICATION TO ^{3}He. Andersen, C. M. (Purdue Univ., Lafayette, Ind.); Gartenhaus, S.; Stranahan, G. Phys. Rev., 146: 101-9(June 3, 1966).

A study is made of a certain model hamiltonian which describes a system of fermions. Making use of the variational results of Girardeau one can obtain, in the limit of infinite volume, an explicit formula for the free energy in terms of the solution of a nonlinear integral equation. It is established that for certain values of the coupling constant the model exhibits condensation, and that qualitatively at least, the isotherms for the model reproduce those for actual physical systems. The model is applied to ^{3}He and it is shown that by a suitable choice for the parameters of the model, reasonable agreement with the low-temperature properties of ^{3}He is obtained. The second virial coefficient for ^{4}He is also reproduced with the same parameter values that give the correct virial coefficient for ^{3}He. (auth)

28079 EQUILIBRIUM BINARY CORRELATIONS IN A CLASSICAL RELATIVISTIC HOMOGENEOUS ELECTRON GAS. De Gottal, Ph. (Univ., Brussels). Physica, 32: 548-60(Mar. 1966).

An expression for the binary correlation Fourier transform in a relativistic classical electron gas is derived using the Liouville equation for matter plus field. In many cases, the temperature of matter does not equal that of radiation; it is shown that the two particles correlation depends in a very crucial way on the difference between the particles and field temperatures. The well known cases of the black body and electromagnetic vacuum field distributions are easily recovered. It is shown that due to the absence of the law of action and reaction for electromagnetic forces, no relativistic Boltzmann factor exists in the electromagnetic vacuum case and that the methods of equilibrium statistical mechanics to calculate thermodynamic properties fail. (auth)

28080 STRUCTURE AND ACTION OF AN ELECTRICAL GAS DISCHARGE. Schulz, G. pp 488-516 of Physikertagung 1965 Frankfurt (M)-Hoechst, Okt. 4-9. Plenarvortraege. Stuttgart, B. G. Teubner Verlagsgesellschaft mbH, 1965. (In German).

For lead abstract see CONF-651030-(Vol.2) in report number index.

The phenomena of an electrical gas discharge are described on the basis of the two fundamental concepts: scattering cross section and distribution function. (J.S.R.)

28081 OVERSTABILITY IN THE MAGNETOHYDRODYNAMIC BENARD PROBLEM AT LARGE HARTMANN NUMBERS. Gibson, R. D. (Univ. of Newcastle upon Tyne, Eng.). Proc. Cambridge Phil. Soc., 62: 287-99 (Apr. 1966).

The possibility of instability arising as overstability in the magnetohydrodynamic Bénard problem is discussed. Results are derived for large Hartmann numbers when the regions outside the fluid layer are conducting or insulating, the interfaces being rigid or free. (auth)

28082 VALIDITY CONDITIONS FOR THE BOLTZMANN EQUATION DERIVED USING THE SUPERLATTICE REPRESENTATION. McIrvine, E. C. (Ford Motor Co., Dearborn, Mich.). Proc. Phys. Soc. (London), 88: 541-3 (June 1966).

By using the superlattice representation, the classical Boltzmann equation may be derived for inhomogeneous quantum fluids. The validity condition for the derivation, as originally given by McIrvine, is compared with that given in a recent rederivation by Holland. (auth)

28083 MAGNETOHYDRODYNAMIC STAGNATION-POINT FLOW. Gribben, R. J. (Univ. of Southampton, Eng.). Quart. J. Mech. Appl. Math., 18: 357-84(Aug. 1965).

A discussion of the axisymmetric, MHD flow of an incompressible, viscous, conducting fluid near a stagnation point when the magnetic field lines are circles parallel to the surface, the diffusion number, ϵ, is small, and the Alfvén number, β, is of order one is given. The method of analysis is basically that of Glauert, where series expansions for the velocity and magnetic fields valid in the viscous and magnetic boundary layers are matched. The results are compared with the numerical solutions when $\epsilon = 1/16$, $\beta = 1$ and the error in the profiles, when two terms of the series are used, is less than 4%. A two-dimensional stagnation-point problem in which the magnetic field lines, parallel to the surface, and the streamlines lie in the same planes is also briefly treated and an exact solution obtained. The matching series expansions in the two layers corresponding to this flow are both obtained directly and derived from the exact solution. (auth)

28084 DEVELOPMENT OF MAGNETOHYDRODYNAMIC BOUNDARY LAYER ON A SOLID BODY. Vatazhin, A. B. Zh. Prikl. Mekh. Tekh. Fiz., No. 4, 40-4(July-Aug. 1965). (In Russian).

The development of a plane MHD boundary layer upon the sudden excitation of motion of a solid is examined. It is assumed that the velocity and enthalpy distributions along the contour of the solid are given for t = 0. At this moment the mechanisms of viscosity and thermal conductivity take effect instantaneously. Viscous and thermal boundary layers begin to grow perpendicular to the solid. The medium in the layers interacts with the magnetic field. This formulation of the problem corresponds to the development of a MHD boundary layer on a solid which is set abruptly into motion, in the case when the rate of establishing MHD flow around the solid in a nonviscous and nonconducting medium is much greater than the rate of development of the boundary layer. Then the velocity and enthalpy distributions are found from the solution of the problem of stationary MHD flow around a solid in a nonviscous and nonconducting medium, or simply of hydrodynamic flow around a solid, if the medium interacts with the field only in the boundary layer. (tr-auth)

28085 EFFECT OF WALLS ON OVERHEAT INSTABILITY IN A MAGNETOHYDRODYNAMIC CHANNEL. Kulikovskii, A. G.; Regirer, S. A. Zh. Prikl. Mekh. Tekh. Fiz., No. 5, 34-9(Sept.-Oct. 1965). (In Russian).

The stability of the temperature field in a plane-electric discharge channel is studied analytically, using simplifying assumptions. The plasma flow is assumed to be incompressible, moving at a constant velocity and bounded by two

electrodes at constant temperature and electric potential. It is assumed that the conductivity depends on the unperturbed temperature T_0 only. The particular solution for the equations is postulated by temperature and electric potential functions. For large values of the wavelength a self-adjoint equation is obtained for the perturbed temperature field. This leads to the following stability criteria. The transition to an unstable condition is connected with a bifurcation in the solution of the unperturbed temperature field equation. Also a transcendental whose roots indicate that the temperature field remains stable to large wavelength oscillations is obtained. This is also true for short wavelength perturbations if $k \geq 0$. (ATD)

28086 CONTRIBUTION TO THEORY OF PULSED DISCHARGES IN A LIQUID MEDIUM. Arsent'ev, V. V. Zh. Prikl. Mekh. Tekh. Fiz., No. 5, 51-7(Sept.-Oct. 1965). (In Russian).

Equations for the energy balance, the number of particles, and the rate of channel expansion for the case of a pulsed underwater discharge are derived. Since the general hydrodynamic equations with boundary conditions on the channel interface and on the shock-wave front are too nonlinear to be used for the solutions of these equations, several simplifying assumptions are made. One is the experimental fact that the rate of expansion of the channel is constant during the first quarter cycle of the discharge, so that the problem becomes similar to that of an expanding piston and self-similar solutions can be obtained. Another simplification is attained by assuming the liquid between the discharge channel and the shock-wave front to be incompressible. It is shown that a stationary channel expansion mode exists in which the shock wave moves without a change in the characteristics. This stationary mode corresponds to a shock-wave velocity of 1600–2000 m/sec. The efficiency with which the electric energy of the discharge is converted into mechanical shock-wave energy is estimated. The calculations are compared with some experimental data. (ATD)

28087 EXPERIMENTAL INVESTIGATION OF A MAGNETICALLY BALANCED ARC IN A TRANSVERSE ARGON FLOW. Lysen, J. C. (Univ. of Missouri, Columbia); Myers, T. W.; McKinnon, C. N. Chicago, American Society of Mechanical Engineers, 1965, Paper 65-WA/Ener-1, 4p., $1.50.

An experimental study of an electric arc in crossed convective and magnetic fields was made. An electric arc was established across a rectangular test section through which argon gas was flowing at approximately atmospheric pressure and velocities up to 100 m/sec. Magnetic field strengths up to 3 webers/m^2, oriented so that the Lorentz force opposed the convective force on the arc, were applied perpendicular to both the arc and the direction of the argon gas flow. The test apparatus and the procedure used to obtain the experimental relationship between the velocity of the argon flow and the balancing magnetic field are described. An analysis which assumed the magnetically balanced arc to be a gaseous cylinder positioned between the electrodes and with a diameter varying directly as the arc current satisfactorily explained the observed dependence of the balancing magnetic field on the gas velocity. (auth)

28088 TEXTBOOK OF MAGNETOHYDRODYNAMICS. Shercliff, J. A. Oxford-New York, Pergamon Press, 1965. 265p. $3.95.

The traditional MKS system of units is used. The emphasis is on vorticity and the importance of the rotationality of the magnetic body force. This view is considered inadequate in the case of deformable fluid conductors which are incapable of sustaining shear stress. The fluid pressure can withstand irrotational force fields, but any rotational magnetic force can elude the pressure and produce or affect fluid motions. The idea that a magnetic force can push a fluid and the question of whether it tends to spin the fluid elements as well are considered. (Int. Aerospace Abstr.)

28089 THE THEORY OF QUANTUM LIQUIDS. VOLUME I. NORMAL FERMI LIQUIDS. Pines, David; Nozieres, Philippe. New York and Amsterdam, W. A. Benjamin, Inc., 1966. 363p.

The Landau theory is described and is applied to liquid ^{3}He and conduction electrons in metals. The mathematical theory of linear response and correlation is developed and applied to neutron scattering, electromagnetic response, and dynamic screening in metals. Differences between neutral and charged liquids are analyzed. Microscopic theories of the electron liquid, ranging from the random phase approximation to recent approximate accounts of metallic behavior are presented and criticized. (B.G.D.)

28090 RAREFIED GAS DYNAMICS. Proceedings of the Fourth International Symposium held at University of Toronto, 1964. Supplement 3. Volume II. de Leeuw, J. H. (ed.). Advances in Applied Mechanics. New York, Academic Press, 1966. 622p. $18.50. (CONF-640704–(Vol.2)).

Thirty-two papers are presented on rarefied gas dynamics which include topics of plasma flows, experimental methods, molecular beams, and surface interactions. (B.G.D.)

28091 RAREFIED GAS DYNAMICS. Proceedings of the Fourth International Symposium held at University of Toronto, 1964. Supplement 3. Volume I. de Leeuw, J. H. (ed.). Advances in Applied Mechanics. New York, Academic Press, 1966. 714p. $19.50. (CONF-640704–(Vol.1)).

A collection of articles on topics of current research interest in fluid dynamics is presented. The emphasis is on very high speed flow problems associated with reentry conditions and explosion. Topics discussed are kinetic theory, shock structure, experimental and theoretical transition flow, and free molecular and internal flow. (B.G.D.)

Geophysics

Refer also to abstracts 27702, 27771, 27774, 27783, and 28505.

28092 STUDY OF THE PROPAGATION OF AN ALFVEN WAVE IN A MEDIUM SLIGHTLY VARIABLE WITH TIME. Fitremann, M.-Y. (Institut d'Astrophysique, Paris). Ann. Astrophys., 29: 143-8(Mar.-Apr. 1966). (In French).

The WKB method is applied to the propagation of an Alfvén wave in a slowly varying medium and the changes in time amplitude and phase of the Alfvén wave are determined to a first approximation. (auth)

28093 GENERALIZATION OF MEASUREMENT OF THE INTENSITY OF VERTICAL AND HORIZONTAL COMPONENTS OF THE TERRESTRIAL MAGNETIC FIELD WITH THE PROTON MAGNETOMETER. de Vuyst, A. P.; Hus, J. J. (Institut Royal Meteorologique de Belgique, Brussels). Ann. Geophys., 22: 119-27(Jan.-Mar. 1966). (In French).

A method of measuring the intensity of the components of the geomagnetic field is described together with the instrumentation that is used. (D.C.W.)

28094 AURORAL ABSORPTION OF COSMIC RADIO NOISE. Eather, R. H. (Dept. of External Affairs, Melbourne. Univ. of New South Wales, Kensington); Jacka, F. Austral. J. Phys., 19: 215-39(Apr. 1966).

Inconsistencies in previous work on the association of auroras with ionospheric absorption of cosmic radio noise are discussed and attributed to a number of experimental factors. Such "auroral absorption" events observed at the Australian National Antarctic Research Expeditions station at Mawson may be classified into four types: day-time events, weak night-time ionospheric absorption, sudden ionospheric absorption (SIA), slowly varying ionospheric absorption (SVIA). During SIA events, peaks of absorption and auroral (λ5577) intensity are simultaneous and the ab-

sorption is limited to the luminous regions of the sky. During SVIA events, the absorption is more widespread and there is little correlation between absorption fluctuations and auroral intensity fluctuations; the ratio of absorption to intensity may be of the order of 100 times greater than in SIA events. The variation observed in the absorption/intensity ratio from event to event, and within single events, is attributed to changes in the incident electron energy spectrum. Spectra varying as $\exp(-\epsilon/\beta)$ are considered and a range in β from 5 to 24 kev is required to explain SIA events; this is in good agreement with rocket data. Consideration of the day/night ratio, two-frequency measurements, and simultaneity of auroral intensity and riometer absorption leads to a lower limit to the height of the absorbing region varying from 80 to 95 km, depending on the electron energy spectrum. Comparison of riometer and Hβ photometer records suggests that protons are important in explaining SVIA events and could in fact be solely responsible. (auth)

28095 NOVEL IONOSPHERIC CYCLOTRON RESONANCE PHENOMENON OBSERVED ON ALOUETTE I DATA. Muldrew, D. B.; Hagg, E. L. (Defence Research Telecommunications Establishment, Ottawa). Can. J. Phys., 44: 925-39(May 1966).

Characteristics of an extraordinary wave trace recently identified on Alouette I topside ionograms, and called the remote resonance trace by Hagg (1966), are discussed in detail. From the observations it has been deduced that the radio energy associated with the production of this trace propagates along an ionospheric magnetic field-aligned wave guide. The electric field of an h-f wave propagating along such a guide would have a gradient normal to the earth's magnetic field, and because of this gradient the wave could excite an electron-cyclotron resonance in a region of the ionosphere that includes the height where the wave frequency is equal to twice the electron gyrofrequency. At some time delay after the wave has passed through the resonant region, the resonating electrons generate an extraordinary wave, which propagates upward along the guide and is subsequently received by the satellite. This wave is responsible for the production of the remote resonance trace. The equation for the time delay is given and the resonance trace computed, using this equation, is shown to be in good agreement with the observed resonance trace for a specific ionogram. (auth)

28096 FREQUENCY VARIATION IN IONOSPHERIC CYCLOTRON HARMONIC SERIES OBTAINED BY THE ALOUETTE I SATELLITE. Barrington, R. E.; Herzberg, Luise (Defence Research Telecommunications Establishment, Ottawa). Can. J. Phys., 44: 987-94(May 1966).

Ionograms produced by the Alouette I topside sounder frequently show well-developed series of cyclotron harmonics. Their frequencies were determined from A (amplitude) scans with an accuracy of ~0.02 Mc/s for the sweep range of 1 to 6 Mc/s. In all cases examined, the frequencies of all of the members of the harmonic series are, within the experimental accuracy, integral multiples of the cyclotron frequency derived from the best present estimates of the earth's magnetic field strength at the satellite height. This result is discussed in the light of recent laboratory results and theoretical studies. (auth)

28097 DETERMINATION OF THE VERTICAL ELECTRON-TRANSPORT VELOCITY IN THE IONOSPHERE. Serafimov, K. (Geophysikalisches Institut, Sofia). Dokl. Bolg. Akad. Nauk, 18: 735-8(1965). (In German).

The derivation of an expression for the vertical electron-transport velocity, W, in the ionosphere, which yields the true (and not the virtual) value of W with an accuracy to the constant of integration (initial velocity W_ζ) is given. A procedure for determining W_ζ is proposed. (Int. Aerospace Abstr.)

28098 IONOSPHERE AND PLASMA IN NEAR SPACE ACCORDING TO SOVIET ROCKET OBSERVATIONS. Gringauz, K. I. Geofiz. Biul., No. 14, 110-15(1965). (In Russian).

A discussion is given of the effects of recent rocket observations on the evolution—during the IGY and following years—of concepts of the structure and expansion of ionosphere. Soviet and American space-ionization data obtained from rockets are briefly reviewed, including Mars 1 data that suggest the existence of ionospheric conditions as far as ~20,000 km from the earth. (Int. Aerospace Abstr.)

28099 TRANSPORT AND ACCELERATION OF CHARGED PARTICLES IN THE EARTH'S MAGNETOSPHERE. Tverskoi, B. A. Geomagn. Aeronomy (USSR) (Engl. Transl.), 5: 617-28(1965).

Translated from Geomagn. Aeronomiya, 5: 793-808 (1965).

Charged particle transport theory is given for the structure of the magnetosphere and radiation belts. A general description of the radiation belts, transport theory, proton radiation belts, and fast electrons are discussed. (J.F.P.)

28100 THEORY OF MOVING IONOSPHERIC DISTURBANCES (MAGNETOHYDRODYNAMIC ABSORPTION). Gershman, B. N.; Grigor'ev, G. I. (Gor'kii State Univ., USSR). Geomagn. Aeronomy (USSR)(Engl. Transl.), 5: 656-60(1965).

Translated from Geomagn. Aeronomiya, 5: 843-9(1965).

Magnetohydrodynamic absorption of internal gravity waves in the F layer of the ionosphere is analyzed. The results of computations as applied to moving disturbances show that this absorption is significant (especially during the daytime at heights of ~300 km). (auth)

28101 ENERGY CHARACTERISTIC OF IONOSPHERIC DISTURBANCES AND THE NATURE OF GEOMAGNETIC AND IONOSPHERIC DISTURBANCE. Kuleshova, V. P.; Mogilevskii, E. I. (Inst. of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, Academy of Sciences, USSR). Geomagn. Aeronomy (USSR)(Engl. Transl.), 5: 661-6(1965).

Translated from Geomagn. Aeronomiya, 5: 850-7(1965).

The planetary characteristic of ionospheric disturbance, ΔI_d, is compared with the energy characteristic of a geomagnetic storm, E. It is shown that there is a correspondence between the active periods of geomagnetic and ionospheric disturbances, which reflect the structure of the magnetic field of a solar corpuscular stream with a force free magnetic field. The relation between ΔI_d and E is determined from the ionization equilibrium equation for the entire thickness of the ionosphere. The dependence of the change in the temperature of the exosphere and ionosphere on E, obtained from the drag of satellites, is used. The transfer of the energy of a disturbance from the magnetosphere to the ionosphere through low-frequency hydromagnetic waves, dissipating in the ionosphere, is discussed. (auth)

28102 QUIET SOLAR-DIURNAL VARIATIONS DURING THE IGY. III. MAIN CHARACTERISTICS OF THE PLANETARY DISTRIBUTION OF S_q VARIATIONS AT MIDDLE AND LOW LATITUDES. Fatkullin, M. N.; Fel'dshtein, Ya. I. (Inst. of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, Academy of Sciences, USSR). Geomagn. Aeronomy (USSR) (Engl. Transl.), 5: 667-74 (1965).

Translated from Geomagn. Aeronomiya, 5: 858-67(1965).

Some results are reported of a study of the morphology of quiet solar-diurnal variations of the geomagnetic field at middle and low latitudes, based on IGY data. In particular, the coordinates of the focal points of S_q current systems and of the equatorial electrojet at various instants of UT are determined and the selection of an appropriate coordinate system for the analytical representation of the planetary distribution of S_q variations is discussed. Analysis of the morphology of S_q variations shows that the field of S_q variations has no geographic nor geomagnetic symmetry. The isolines of S_q variations are constructed and their main types are discussed briefly. The relation between the equatorial electrojet and S_q current systems is also examined. (auth)

28103 MICROPULSATIONS OF THE GEOMAGNETIC FIELD AND DYNAMICS OF THE MAGNETOSPHERE.

Bol'shakova, O. V. (Inst. of Terrestrial Physics, Academy of Sciences, USSR). Geomagn. Aeronomy (USSR) (Engl. Transl.), 5: 675-9(1965).

Translated from Geomagn. Aeronomiya, 5: 868-73(1965).

The relation between pulsation periods and the dimensions of the magnetosphere is examined on the basis of the inverse dependence of the periods of micropulsations on the magnetic activity level. Indirect observations of this relation during recurrent storms are borne out by a comparison of pulsation periods with direct satellite measurements of the dimensions of the magnetosphere. (auth)

28104 PULSATIONS OF AURORAL LUMINOSITY AND IRREGULAR SPP OF THE GEOMAGNETIC FIELD. Skrynnikov, R. G. (Inst. of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, Academy of Sciences, USSR). Geomagn. Aeronomy (USSR)(Engl. Transl.), 5: 680-3(1965).

Translated from Geomagn. Aeronomiya, 5: 874-7(1965).

The dynamo theory of irregular SPP of the geomagnetic field, appearing during bay-like polar disturbances, is discussed. A formula is proposed which relates the amplitudes of SPP with pulsations of auroral luminosity. (auth)

28105 RESULTS OF AURORAL HEIGHT DETERMINATIONS AT TIXIE BAY IN 1964. Andrienko, D. A. (Kiev State Univ.). Geomagn. Aeronomy (USSR)(Engl. Transl.), 5: 684-8(1965).

Translated from Geomagn. Aeronomiya, 5: 878-83(1965).

The results are reported of determinations of auroral heights from large-scale photographs obtained at Tixie Bay in January–March 1964. The height distribution curves of the lower edge of homogeneous arcs and rayed forms have three maxima. The existence of a coastal effect in auroral heights is confirmed. The results of determinations of the heights of the upper edge, the vertical extent of homogeneous arcs and bands, and of the length of arcs in a corona are presented. (auth)

28106 MEASUREMENT OF THE NEUTRON FLUX IN THE ATMOSPHERE BY THE INDIUM ACTIVATION METHOD. Efimov, Yu. E.; Romanov, A. M. (Ioffe Inst. of Physics and Tech., Leningrad). Geomagn. Aeronomy (USSR)(Engl. Transl.), 5: 720-2(1965).

Translated from Geomagn. Aeronomiya, 5: 921-3(1965).

The results of neutron flux measurements at atmospheric depths from 78 to 188 g/cm^2 are reported. The measurements were made in 1964 at a geomagnetic latitude $\lambda_m = 57°$N on magnetically quiet days. Targets were exposed at the given heights for 1 to 2 hours. The activation rates, the average value for the neutrons/cm^2 sec, and the total flux of neutrons of energy about 1 ev for latitude $\lambda_m = 57°$N and an atmospheric depth of 69 g/cm^2 in years of solar minimum are determined and given. (J.F.P.)

28107 ATTENUATION OF LONGITUDINAL ION WAVES IN PLASMA. Bud'ko, N. I. (Inst. of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, Academy of Sciences, USSR). Geomagn. Aeronomy (USSR)(Engl. Transl.), 5: 726-8(1965).

Translated from Geomagn. Aeronomiya, 5: 927-9(1965).

The dispersion equation for a homogeneous isotropic plasma is analyzed in order to estimate the expected effects from longitudinal plasma wave emission by an artificial satellite moving in the ionosphere. (J.F.P.)

28108 RADIO NOISE ORIGINATING IN THE IONOSPHERE DURING IONIZATION BY CORPUSCULAR STREAMS. Rapoport, V. I.; Eidman, V. Ya. (Gor'kii State Univ., USSR). Geomagn. Aeronomy (USSR)(Engl. Transl.), 5: 729-30(1965).

Translated from Geomagn. Aeronomiya, 5: 930-1(1965).

It is shown that the observed ionospheric radio noise which seems to be associated with the penetration of strong corpuscular streams into the earth's ionosphere can apparently be explained by the emission from electrons which were detached from molecules by fast particles of corpuscular streams. (J.F.P.)

28109 ANOMALOUS POLAR CAP ABSORPTION. Gachechiladze, R. G.; Khocholava, G. M. (Tbilisi State Univ., USSR. Inst. of Geophysics, Academy of Sciences, Georgian SSR). Geomagn. Aeronomy (USSR)(Engl. Transl.), 5: 733-4(1965).

Translated from Geomagn. Aeronomiya, 5: 934-6(1965).

The complex of disturbance producing the anomalous absorption in the polar cap on April 10, 1958, is investigated in detail, and an attempt is made to explain it. (J.F.P.)

28110 SPORADIC IONIZATION OF THE AURORAL TYPE IN THE E REGION. Shchuka, T. I. Geomagn. Aeronomy (USSR)(Engl. Transl.), 5: 735-8(1965).

Translated from Geomagn. Aeronomiya, 5: 937-8(1965).

Sporadic ionization in the E region associated with auroras is defined as seen mainly at high latitudes, usually at night and accompanied by an increase in magnetic activity and auroras. It has a well-defined flat or gradually increasing lower edge with stratifications and diffuse reflections above them. The diffuse part of the trace sometimes extends over several hundred kilometers of effective height. A comparison of ionograms and all-sky camera film showed three types to be the most frequent. These types are described and shown. Characteristics of reflections on ionograms are given for the identification of E-region sporadic ionization. (J.F.P.)

28111 LOCATION OF THE AURORAL ZONE CURRENT AS A FUNCTION OF STORM INTENSITY. Glushkova, E. P. (Inst. of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, Academy of Sciences, USSR). Geomagn. Aeronomy (USSR)(Engl. Transl.), 5: 741-2(1965).

Translated from Geomagn. Aeronomiya, 5: 941(1965).

The latitude over which the auroral zone current flows for geomagnetic storms of various intensities was determined using data from Dombas ($\phi = 62.1^0$, $\lambda = 9.1^0$, and $\Phi = 62.3^0$) and Tromsö ($\phi = 69.7^0$, $\lambda = 19^0$, and $\Phi = 67^0$). These stations were selected because their longitudes are very similar, they are located in most cases on opposite sides of the auroral zone current, and the effect of aperiodic variations in this region is insignificant. The position of the current was determined for two storm periods during which ΔH has maximum and minimum values at Dombas. The current was assumed to be linear. (J.F.P.)

28112 RELATIONSHIP BETWEEN E_s AND MAGNETIC FIELD VARIATIONS. Ovezgel'dev, O. (Dept. of Geophysics and Seismology, Academy of Sciences, Turkmen SSR). Geomagn. Aeronomy (USSR)(Engl. Transl.), 5: 742-4(1965).

Translated from Geomagn. Aeronomiya, 5: 944(1965).

The relation between the sporadic E layer of the ionosphere and diurnal geomagnetic field variations were examined previously. Results of subsequent analyses using data from the Ashkhabad ionospheric station and magnetic observatory for May to August, 1962, August, 1961, and June, 1960, are reported. It is found that there is no relation between the sporadic E layer and the irregular variation of the geomagnetic field components. (J.F.P.)

28113 ANALYSIS OF THE GEOMAGNETIC FIELD AND ITS SECULAR VARIATIONS. Zidarov, D.; Bochev, A. Geomagn. Aeronomy (USSR)(Engl. Transl.), 5: 746-9(1965).

Translated from Geomagn. Aeronomiya, 5: 948-9(1965).

It is demonstrated that the difference in the position and magnetic moments of the corresponding dipoles for two different epochs can provide information on the secular variations of current systems (dipoles) in the earth and on some properties of magnetic masses close to the earth's surface. (J.F.P.)

28114 EXCESSIVE ABSORPTION IN THE LOWER NOCTURNAL IONOSPHERE AT MIDDLE GEOMAGNETIC LATITUDES DURING FORBUSH EFFECTS. Nestorov, G. (Geofizicheski Institut, Sofia); Krzhivski, L.; Letfus, V. Izv. Geofiz. Inst., B'lgarska Akad. Nauk., 7: 29-35 (1965). (In Bulgarian).

Results of observations of the absorption of cosmic radiation in the nocturnal ionosphere, noting increased absorption on days with a Forbush effect, are given. Relations are established, at 155 cps and a 63° angle of incidence of the electromagnetic wave, between the geomagnetic activity, the intensity of cosmic rays, and their reflection from the nocturnal D layer. The increased absorption is linked to

corpuscular fluxes that obstruct the passage of galactic radiation through the ionosphere. The contribution of cosmic radiation to ionization of the nocturnal D layer is confirmed by the results of observations from Apr. 28 to May 12, 1960. (auth)

28115 RECOMBINATION COEFFICIENT AND ELECTRON PRODUCTION RATE IN THE LOWER D REGION DURING SOLAR FLARES. Nestorov, G. (Geofizicheski Institut, Sofia); Taubenheim, J. Izv. Geofiz. Inst., B'lgarska Akad. Nauk., 7: 37-47(1965). (In Bulgarian).

An analysis of the complete equation for recombination balance in the D region in the presence of 0.1- to 5.0-Å radiation from solar flares is given. The equation is solved for weak, medium, and powerful flares and the recombination coefficient is determined for each type. An equation for variations of α^1 with height is set up from simultaneous observations of ionospheric effects at several frequencies. An expression is derived relating the ionization function and the electron concentration and permitting a fairly accurate determination of the effective recombination coefficient and electron formation rate. These equations are applied to the ionospheric effects of 400 solar flares observed from 1959 to 1963. (Int. Aerospace Abstr.)

28116 ADDITIONAL ABSORPTION OF COSMIC RADIO EMISSION IN THE IONOSPHERE DURING THE PERTURBATION OF APRIL 18, 1965. Belikovich, V. V.; Benediktov, E. A. (Gor'kii State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 9: 399-400(1966). (In Russian).

Preliminary results are presented of measurements of the magnitude of anomalous polar-type radio-wave absorption in the ionosphere, recorded on Apr. 18, 1965, at Zimenka—a rare event at middle latitudes and during a time of minimum of solar activity. The measurements were obtained by the radioastronomical method simultaneously at frequencies of 8.5, 8.9, 13, and 24.6 Mc. (M.J.T.)

28117 RECOMBINATION COEFFICIENT AND THE PRE-NOON MAXIMUM OF ELECTRON DENSITY IN IONOSPHERIC F2 REGION. Awojobi, O. A. J. Atmos. Terrest. Phys., 28: 375-84(Apr. 1966).

It is shown that a solution of the equation of continuity for electrons based on production and loss alone leads to loss rates that are considerably higher than was previously assumed. This new loss rate is so high that the turning point in the resulting electron density-time curve appears hours before noon as has been long observed at low latitudes. It is suggested that this result is significant because this pre-noon maximum is generally associated with either electromagnetic movement or plasma diffusion. (auth)

28118 BALLOON OBSERVATIONS OF INFRARED AND X-RAY INTENSITIES IN THE AURORAL ZONE. Wax, R. L. (Univ. of California, Berkeley). J. Atmos. Terrest. Phys., 28: 397-407(Apr. 1966).

Simultaneous observations of infrared emissions and auroral zone x-rays from a series of high-altitude balloon flights are reported. In addition to infrared nightglow from OH, fluctuations of the infrared intensity due to aurora were observed. In general, the correlations between the optical emissions and the x-rays was poor, indicating a loose coupling between the low- and high-energy portions of the auroral electron spectrum. (auth)

28119 ON THE THEORY OF THE SUDDEN ENHANCEMENT OF ATMOSPHERICS (SEA). Volland, H. (Univ. of Bonn). J. Atmos. Terrest. Phys., 28: 409-23(Apr. 1966).

The variation of the field strength of atmospherics in the v-l-f region during a solar flare is studied. The influence of the detector of a receiver with a narrow band-pass on the integrated field strength is considered, and a relation is derived between the input number of atmospherics and the rectified output voltage of the receiver. The input number (N) of atmospherics exceeding the threshold field strength of the receiver is calculated as is the variation of N during a solar flare due to the decrease of the height of the ionospheric wave-guide. (D.C.W.)

28120 CORRELATION OF OPTICAL AND RADIO AURORAS. Bates, H. F.; Belon, A. E.; Romick, G. J.; Stringer, W. J. (Univ. of Alaska, College). J. Atmos. Terrest. Phys., 28: 439-46(May 1966).

A comparison of simultaneous optical and radio auroral data obtained during 12 days in December, 1964, shows conclusively that the radio wave scattering belt includes the visual auroral belt. The optical data were obtained with the Alaskan network of all-sky cameras located between 65 and 80° north geomagnetic latitude. The multifrequency backscatter sounder operating at College was used to record the radio data. The excellent agreement that resulted leads to the conclusion that the majority of the h-f and low v-h-f backscatter echoes originating in the E and the F regions at high latitudes are auroral echoes in the strict sense of the term. In the records shown the auroral belt was tracked from 65 to above 80° north geomagnetic latitude by a single sounder. It is concluded that the multifrequency h-f backscatter sounder makes year-round observations of the auroral belt possible. (auth)

28121 ELECTRON DENSITIES IN THE E- AND D-REGIONS ABOVE KJELLER. Piggott, W. R. (Radio and Space Research Station, Slough, Eng.); Thrane, E. V. J. Atmos. Terrest. Phys., 28: 467-79(May 1966).

Models of the ionization density and collision frequency in the D and E region are constructed for Kjeller, Norway, at a March equinox when the sunspot number was about 110. Data from rocket measurements, wave interaction and from the measurements of absorption and height of reflection of radio waves on a number of frequencies in the h-f band are used and the agreement with the experimental observations is satisfactory. The models were compared with v-l-f and l-f propagation results. (auth)

28122 DYNAMICS OF THE AURORA. IV. POLAR MAGNETIC SUBSTORMS AND WESTWARD TRAVELING SURGES. Akasofu, S.-I.; Meng, C.-I.; Kimball, D. S. (Univ. of Alaska, College). J. Atmos. Terrest. Phys., 28: 489-96(May 1966).

Polar magnetic substorms associated with the westward traveling surge are examined in detail, using an extensive all-sky and magnetic networks in Canada–Alaska–Siberia. Since the surge is accompanied by an intense negative bay and since it advances into the polar cap along the auroral oval during the auroral substorm, the region in which a negative bay is observed expands along the path of the surge. Thus, as it was previously suggested, the so-called westward electrojet extends into the polar cap, rather than being terminated in the midnight sector of the auroral zone. (auth)

28123 DYNAMICS OF THE AURORA. V. POLEWARD MOTIONS. Akasofu, S.-I.; Kimball, D. S.; Meng, C.-I. (Univ. of Alaska, College). J. Atmos. Terrest. Phys., 28: 497-503(May 1966).

The poleward motion of auroral bands in the midnight sector during the early phase of the auroral substorm is described. Several examples are presented and discussed in detail. The polar magnetic substorm associated with the poleward motion is also examined. Since the poleward motion initiates all the other aspects of the auroral substorm (such as the westward traveling surges and the formation of patches), it is essential to understand this phenomenon in order to explore the cause of the planetary-scale auroral displays. It is shown that the auroral substorm is initiated in the auroral oval itself and that before or during the substorm there are no equatorward auroral motions across the dipole pole from the dayside to the nightside along the noon-midnight meridian. (auth)

28124 DYNAMICS OF THE AURORA. VI. FORMATION OF PATCHES AND THEIR EASTWARD MOTION. Akasofu, S.-I.; Meng, C. I.; Kimball, D. S. (Univ. of Alaska, College). J. Atmos. Terrest. Phys., 28: 505-11 (May 1966).

The formation of patches in the morning sector occurs about 10 ~ 30 min after the onset of the auroral substorm in the midnight sector. This phenomenon is examined in detail by using the IGY Alaska–Canada all-sky magnetic records. Patches drift eastwards and their drift speed is obtained for a number of cases. (auth)

28125 SECONDARY IONIZATION PROCESSES DUE TO PROTON BOMBARDMENT IN AURORAE. Inn, Edward C. Y. (Ames Research Center, Moffett Field, Calif.). J. Atmos. Terrest. Phys., 28: 527-30(May 1966).

It is suggested that excited hydrogen atoms arising from the deposition of protons in the upper atmosphere, as inferred from the observed auroral Hα emission, may provide an important secondary source of auroral ionization. The mechanisms discussed are photoionization of O_2 by Hlβ and collisions of the second kind between excited hydrogen atoms and O_2. (auth)

28126 DAY-TO-DAY VARIATIONS IN THE F2 CRITICAL FREQUENCY. King, G. A. M. (DSIR, N. Z.). J. Atmos. Terrest. Phys., 28: 531-5(May 1966).

From a comparison of ionospheric changes at F1 and F2 heights it is found that most of the variations in foF2 can be attributed to variations in the incident ionizing radiation and in the rate of electron recombination. The ionizing radiation follows fairly closely the 2800 Mc solar radio flux. The recombination rate is affected by ionospheric storms and travelling disturbances, and it also shows a steady drift over the period studied. (auth)

28127 TIME VARIATION IN SMALL-ION DENSITY AT 32 KILOMETERS ALTITUDE. Paltridge, G. W. (Univ. of Melbourne). J. Geophys. Res., 71: 2169-70(Apr. 15, 1966).

A constant level balloon experiment is described for continuously monitoring the ion density in the atmosphere at an altitude of 32 km. Results of irregular fluctuations in the ion density indicate a variation in atmospheric dust pollution. (B.G.D.)

28128 DYNAMICS OF A GEOMAGNETIC TRAP. II. Pletnev, V. D.; Skuridin, G. A.; Chesalin, L. S. Kosm. Issled., 3: 854-76(Nov.-Dec. 1965). (In Russian).

A discussion of several hypotheses concerning the formation of the boundaries of the magnetosphere is given. Particular attention is given to the so-called neutral points on the day and night sides (near the equatorial plane), and to the possibility of a penetration of solar-flux particles into the magnetosphere, both through the neutral points and directly through the boundary layer. The structure of the stationary geomagnetic field at large distances from the earth is examined. (Int. Aerospace Abstr.)

28129 ELECTRON AND ION TEMPERATURES IN THE IONOSPHERE. Breus, T. K.; Gdalevich, G. L. Kosm. Issled., 3: 877-89(Nov.-Dec. 1965). (In Russian).

A discussion of the electron and ion temperatures in the ionosphere, on the basis of theoretical and experimental data is given. It is shown that there is no temperature equilibrium between the electrons and ions in the F region of the ionosphere. A comparison between the theoretical and experimental T_e and T_i values indicates the need for further direct measurements of T_e and T_i and for additional information on thermal sources, such as electrostatic fields, hydromagnetic waves, and high-energy particle fluxes. (Int. Aerospace Abstr.)

28130 DISTRIBUTION OF ELECTRONS WITH E > 40 kev ACCORDING TO ANGLE OF PITCH IN THE INNER BELT, BASED ON DATA OF COSMOS-5. Vaisberg, O. L.; Shuiskaya, F. K. Kosm. Issled., 3: 890-902(Nov.-Dec. 1965). (In Russian).

In June 1962 observers succeeded in obtaining data over several orbital revolutions of "Cosmos 5" on the distribution of directed intensity of electrons with energy >40 kev by pitch angles at altitudes of 1,000–1,600 km. Distributions were plotted of the directed intensity in mirror points on natural geomagnetic coordinates B and L while preserving the magnetic moment. The width of pitch distributions and the corresponding B and L diagrams show the dependence on longitude (or on the local time of the observation point). On the average, the directed intensities computed by pitch distributions are in agreement with the measurements of intensities at an angle of 90° to the force line, which were made during other orbitings through the same drift envelope at longitudes close together. In Pacific longitudes, the directed intensity on the drift trajectories running in the region of the South-Atlantic anomaly at an altitude of 250 km reaches $2(10)^6$ electron/cm^2 · sec · strad for L = 1.5. The width of the pitch distribution remains large in the zone of the South-Atlantic anomaly and thereafter. At longitudes >0° during the daytime the pitch distributions contract, and the intensity along the drift trajectories decreases correspondingly. This phenomenon, evidently, cannot be entirely the result of Coulomb scattering. The variations observed in pitch distributions and intensities, their changes in individual orbiting revolutions, and the systematic decrease of pitch distributions and intensity at longitudes >0° are a weighty argument in support of the existence in the magnetosphere of electric fields of ionospheric origin with a strength of up to 10^{-4}–10^{-5} v/cm. At present, additional analysis of the available material is being conducted in order to evaluate the effect of diurnal and longitudinal factors on the pitch distribution of trapped particles. There are reasons to assume that the measurement of the variations of intensity and pitch angles of soft electrons, which play an important role in the excitation of auroras and in the energy balance of the upper atmospere, may serve also as an effective means for the study of electric fields and circulation in the upper atmosphere and magnetosphere of the earth. (ATD)

28131 UPPER ATMOSPHERIC TEMPERATURES FROM DOPPLER LINE WIDTHS. IV. A DETAILED STUDY USING THE OI 5577 A AURORAL AND NIGHTGLOW EMISSION. Hilliard, R. L.; Shepherd, G. C. (Univ. of Saskatchewan, Saskatoon, Can.). Planet. Space Sci., 14: 383-406(May 1966).

The measurement of Doppler temperatures in the upper atmosphere were continued in Saskatoon, using a field-compensated Michelson interferometer. This device possesses certain advantages over the Fabry-Perot spectrometer, the most important being that its luminosity may be of the order of a thousand times greater at the same effective resolution. A brief description of the instrument and the techniques used in this particular application are given. A large number of temperature values, from both aurora and nightglow, were obtained with this instrument, using the OI 5577 Å line. This made it possible to obtain some correlation with local time, sky position, magnetic field variations, and particularly with emission brightness. The detailed results for the nights of April 7/8, May 10/11 and May 14/15, 1964 are presented. The most striking result is that a systematic relation between the auroral brightness and observed temperature is often obtained over periods up to a few hours. Brightness and temperature are usually inversely related, and changes in the relation were observed to occur at the same time as magnetic bays. This inverse relation is crudely interpreted as following the atmospheric density curve; that is, that a uniform excitation per atom exists down to some cutoff height determined by the particle energy. This cutoff height thus determines both the auroral brightness and the observed temperature. A more quantitative interpretation was given using calculated luminosity distributions. These suggest that while the inverse relation is in effect, auroral brightness (and temperature) changes result primarily from changes in the particle energy spectrum rather than changes in the flux. This systematic relation also seems to preclude the existence of major temperature changes through auroral heating at these levels. The nightglow observations give an average temperature of about 180°R and brightness in the range of 200–300 R, in agreement with observations at lower latitudes. When compared with the auroral data, the indication is that aurora and nightglow are unrelated phenomena in the 5577 Å emission. (auth)

28132 TIME HISTORY OF THE MAGNETOSPHERIC CAVITY. Osborne, F. J. F.; Bachynski, M. P.; Gore, J. V. (RCA Victor Research Labs., Montreal). Radio Sci., 1: 419-25(Apr. 1966).

Scale-model laboratory experiments simulating the effect of the solar wind on the magnetosphere have shown the time

history of the formation and breakup of the magnetospheric cavity. Time-resolved (1 μsec) data on the visible "stand-off" interaction show that the "quasi-Van Allen belts" first become visible well within the cavity at the time the plasma wind encounters the fringing terrella field. The belts at this time show a definite structure with "ribbons" of plasma along the field lines. This structure is probably associated with oscillatory phenomena present in the belts and their excitation mechanism. The polar views show considerable asymmetry of both the internal and external phenomena throughout the interaction. The visual asymmetries indicate that the plasma in the tail of the dipole magnetic field "wags" as the interaction builds up and decays. Magnetic field measurements in the equatorial plane show a similar motion of the magnetic field in the tail. (auth)

28133 ADIABATIC MOTION OF CHARGED PARTICLES IN VARYING MAGNETIC FIELDS. Sakurai, Kunitomo (Kyoto Univ.). Rep. Ionosphere Space Res. Jap., 19: 421-32(1965).

The motion of a charged particle in a magnetic field which varies with space and time is investigated under the guiding-center approximation. The drift motion and the acceleration mechanism of a charged particle are mainly considered. Under the guiding center approximation, the motion of a charged particle is composed of drift motion, motion along a magnetic line of force, and gyration around it. The adiabatic invariants of motion are defined for each degree of freedom concerning the particle motion. The expression for energy gain is shown to be composed of three terms, which are identified with the Fermi I, Fermi II, and betatron accelerations. Consequently, it could be concluded that the real process of particle acceleration under natural circumstances consists of the combined three accelerations mentioned above. Application of the results obtained to the acceleration mechanism of solar cosmic rays and motion of trapped particles in the outer radiation belt is briefly discussed. (auth)

28134 DYNAMIC SPECTRUM OF GEOMAGNETIC PULSATIONS AT LOW LATITUDE. Hirasawa, Takeo (Tokyo Univ.); Oguti, Takasi; Nagata, Takesi. Rep. Ionosphere Space Res. Jap., 19: 452-69(1965).

New recording equipment for geomagnetic pulsations was developed, with a magnetic tape recording technique of slow running. By playing back the tape at an ordinary speed, the frequency of geomagnetic pulsations is stepped up. After repeating this process, it becomes possible to analyze the dynamic spectrum of geomagnetic pulsations of a wide frequency range (from about 0.01 to 1.0 cps), with the aid of a sonagraph. By means of this analyzing method, geomagnetic pulsations observed at Kakioka, Japan, can be classified into seven kinds, which are given. The characteristics of these kinds of geomagnetic pulsations at Kakioka are summarized. New contributions to the morphology of low-latitude pulsations are given. (auth)

28135 LIP-SHAPED PATTERN OF AURORAL IONIZATIONS PRODUCED IN ASSOCIATION WITH ELEMENTARY GEOMAGNETIC POLAR DISTURBANCES. Hakura, Y. (Radio Research Labs., Tokyo); Nagai, M. Rep. Ionosphere Space Res. Jap., 19: 519-20(1965).

The spatial extent of the enhanced ionization area formed at the maximum stage of the geomagnetic bay disturbance is considered. Since the pattern of enhanced ionization defines the spatial extent of the auroral particle precipitation onto the polar ionosphere, this suggests the scale of the neutral sheet in the geomagnetic tail where the electrons responsible for the aurora may be produced. (J.F.P.)

28136 OBSERVATION OF ELECTRON FLUX BY L-3 ROCKETS. Nakagawa, Shigeo (Rikkyo Univ., Tokyo); Tsukuda, Masahiro; Sasaki, Akira; Nagata, Katsuaki; Doke, Tadayoshi. Rep. Ionosphere Space Res. Jap., 19: 521-2(1965).

Intensity distributions of proton and electron fluxes at high altitude from about 200 to 1000 km above the earth's surface were observed by solid state detectors in L-3 rockets. The proton flux intensity was nearly constant during the flight, and the average value is 2 ± 6 protons cm^{-2} min^{-1} str^{-1}. The observed flux intensity is shown. (J.F.P.)

28137 SUMMARY OF DAILY OBSERVATIONAL RESULTS OF SOLAR PHENOMENA, COSMIC RAY, GEOMAGNETIC VARIATION, IONOSPHERE, RADIO WAVE PROPAGATION, AND AIRGLOW DURING JANUARY THROUGH JUNE 1965. Rep. Ionosphere Space Res. Jap., 19: 527-36(1965).

A summary of daily observational results of solar phenomena, cosmic ray, geomagnetic variation, ionosphere, radio wave propagation, and airglow observed in Japan from Jan. to July, 1965, is presented. Representative results from key stations are given rather than all observational results. (J.F.P.)

28138 CATALOG OF DISTURBANCES IN IONOSPHERE, GEOMAGNETIC FIELD, FIELD INTENSITY OF RADIO WAVE, COSMIC RAY, SOLAR PHENOMENA, AND OTHER RELATED PHENOMENA. NO. 49. SEPTEMBER 20-23, 1963. (Ionosphere Research Committee, Tokyo). Rep. Ionosphere Space Res. Jap., 19: 537-68(1965).

Observational data for remarkable disturbances of the ionosphere, geomagnetic field, radio waves, cosmic radiation, and solar, and other related phenomena are presented for September 20th to 23rd, 1963. A geomagnetic storm occurred at this time. (J.F.P.)

28139 VARIATION IN SOLAR WIND INTENSITY WITH PHASE OF SOLAR ACTIVITY CYCLE FROM DATA ON STABLE OSCILLATIONS OF THE GEOMAGNETIC FIELD. Bol'shakova, O. V. (Inst. of Geophysics, Academy of Sciences, USSR). Soviet Astron. AJ (Engl. Transl.), 9: 666-7(Jan.-Feb. 1966).

Translated from Astron. Zh., 42: 859-61(July-Aug. 1965).

The mean amplitude of short-period oscillations (type pc4) of the geomagnetic field corresponding to a solar wind blowing from quiet solar regions (Kp = 0) remained constant over the 1957-1964 period. The inference is drawn that the intensity of the solar wind from quiescent solar regions is unaffected by the phase of the solar activity cycle, in agreement with previous work. (auth)

28140 ADVANCES IN EARTH SCIENCE. International Conference, Massachusetts Inst of Technology, September, 1964. Hurley, P. M. (ed.). Cambridge, Mass. and London, The M.I.T. Press, 1966. 513p. $20.00. 150/-. (CONF-640929).

A collection of papers on the earth sciences, which treat the earth as a whole system permitting examination of the interrelations between various layers of the earth and its outer enviroment is presented. Topics discussed are the sun, solar planetary relationships, examination of large-scale motions of the atmosphere, meteorological phenomena such as fronts, cyclones, and atmospheric turbulence, the dynamics of oceans are considered including large-scale oceanic circulations, coupling of waves, tides, and fluctuations of the sea level. Papers are also presented on the solid earth concerning mantle convection, mechanical properties of the deep earth, advances in seismology, and constitution of the interior. (B.G.D.)

Gravitation, Quantum Mechanics, and Relativity Theory

Refer also to abstracts 27906 and 27992.

28141 (JINR-P-2642) RASSEYANIE DVUKH PLOSKIKH ELEKTROMAGNITNYKH VOLN V NELINEINOI ELEKTRODINAMIKE BORNA-INFEL'DA. (Scattering of Two Plane Electromagnetic Waves in a Nonlinear Electrodynamics of Born-Infeld). Barbashov, B. M.; Chernikov, N. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 14p. Dep. mn.

The scattering problem of two plane waves in classical electrodynamics of Born-Infeld is solved exactly. It turned out that the shape and direction of plane waves after scattering do not change. The wave phase merely changes by a magnitude which is equal to the product of

its frequency by the momentum of the incident wave. It is shown that in the interaction region the solution becomes a many-valued function when the electromagnetic field exceeds a certain quantity which plays the role of an absolute scale of the field. (auth)

28142 VALIDITY IN GENERAL RELATIVITY OF THE SCHWARZSCHILD CRITERION FOR CONVECTION. Thorne, Kip S. (Princeton Univ., N. J.). Astrophys. J., 144: 201-5(Apr. 1966).

Karl Schwarzschild's criterion for convective instability, which is known to be valid in the Newtonian and post-Newtonian theories of gravitation, is shown to be valid also in general relativity theory. (auth)

28143 CONDITIONS FOR THE EXISTENCE OF CLOSED SOLUTIONS BY THE NORMAL ORDERING METHOD. Marburger, J. H. (Stanford Univ., Calif.). J. Math. Phys., 7: 829-32(May 1966).

It is shown that the normal ordering method of solving boson operator equations leads to closed solutions of the Schrödinger and density operator equations only in certain cases. In particular, a necessary condition for the existence of solutions of the form $N\{\exp G(a_i^\dagger, a_i)\}$ with G a finite multinomial is that the hamiltonian be of the general form $H = \Sigma_{i,j}(c_{ij}a_i^\dagger a_j + \tilde{c}_{ij}a_i a_j + \tilde{c}_{ij}^* a_i^\dagger a_j^\dagger) + \Sigma_i(c_i a_i + c_i^* a_i^\dagger) + c$. Approximate solutions may be obtained for the density operator for arbitrary hamiltonians. (auth)

28144 POSSIBILITY OF TESTING COSMOLOGICAL THEORIES FROM THE GRAVITATIONAL LENS EFFECT. Refsdal, S. (Univ. of Oslo). Mon. Notic. Roy. Astron. Soc., 132: 101-11(1966).

The gravitational lens effect is applied to a powerful light source changing rapidly with time and lying far behind and close to the line of sight through a distant galaxy. The possibility of testing cosmological theories is discussed. Special account is taken of the steady state theory and theories based on general relativity. The chance of observing the phenomenon is discussed. (auth)

28145 QUASI-LOCAL ELECTRODYNAMICS. Priou, Maurice (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nucl. Phys., 81: 641-64 (June 1966).

A fully gauge-invariant quantum electrodynamics of massive photons is presented here. The theory is nonlocal, but allows for an expansion in Feynman diagrams as does the usual electrodynamics, the only change being a modification of the photon propagator. The theory uses a set of space-like paths, and in order to secure Lorentz invariance, final results must be averaged over all possible path directions. (auth)

28146 ELABORATION OF A GRAPHICAL METHOD ADAPTED TO IRREDUCIBLE TENSOR OPERATORS. El-Baz, E.; Massot, J. N.; Lafoucriere, J. (Institut de Physique Nucleaire, Lyon). Nucl. Phys., 82: 189-208 (1966). (In French).

The generalization of graphical methods given previously for spherical harmonics can be used for irreducible tensor operators with only some slight modifications. It permits the graphical separation of the physical and geometrical parts of the matrix elements. This method also gives reduced matrix elements of complex products of tensor operators. As a concrete example the calculation of a reduced matrix element of the product of four tensor operators is given. (auth)

28147 RELATIVISTIC MEASURES AND UNITS. Palacios, J. (Univ., Madrid). Nuovo Cimento (10), 43A: 413-22(May 21, 1966).

In reply to the remarks made previously, it is shown that the proper way to derive the transformation formulas is to specify the units used in the measurements performed in both frames of reference. On account of the anisotropic contraction of the moving bodies, the scale factor for the unit of length will depend on the direction considered. Therefore, the transformation formulas for all the physical quantities must be obtained from their dimensional formulas, and it is necessary to discriminate the direction parallel to motion from the transverse directions. (auth)

28148 POSSIBILITY OF A QUANTUM LORENTZ-INVARIANT MACROCAUSAL THEORY. I. Ferretti, B. (Univ., Bologna). Nuovo Cimento (10), 43A: 507-15 (May 21, 1966).

The problem is discussed whether the existence of an ultimate speed of the signals, determined by means of direct experiments, is sufficient, together with the Lorentz invariance, to infer the necessity of microscopical causality as usually expressed by means of the vanishing of certain commutators of "local variables." By means of a counter example this question is given a negative answer, and it is shown how it is possible to define the concept of "macrocausality" in a Lorentz-invariant theory. (auth)

28149 POSSIBILITY OF A QUANTUM LORENTZ-INVARIANT MACROCAUSAL THEORY. II. Ferretti, B. (Univ., Bologna). Nuovo Cimento (10), 43A: 516-28 (May 21, 1966).

A general method is described for constructing models with nonlocal interactions which are from the start Lorentz-invariant and with a positive definite metric. An example of a model constructed following this general procedure is then discussed under the point of view of the "macrocausal" behavior defined previously. (auth)

28150 CAUSAL ANOMALIES IN THE EXTENDED SCHWARZSCHILD MANIFOLD. Israel, W. (Univ. of Alberta, Edmonton). Phys. Lett., 21: 47-9(Apr. 15, 1966).

The elliptic interpretation of the extended Schwarzschild manifold leads to a number of causal anomalies connected with the existence of closed time-lines within radii comparable to the Schwarzschild radius. Arguments are given in support of the thesis that causal violations cannot occur under actual physical conditions. (auth)

28151 RELATIVISTIC ENERGY-MOMENTUM TENSOR IN A DIELECTRIC. de Groot, S. R.; Suttorp, L. G. (Inst. of Theoretical Physics, Amsterdam). Phys. Lett., 21: 297-8(May 15, 1966).

The relativistic energy-momentum tensor of the electromagnetic field is derived from electron theory and compared with the forms proposed by Abraham and Minkowski. (auth)

28152 POSSIBLE EXPERIMENTAL TEST OF THE EXISTENCE OF A UNIVERSAL LENGTH. Redei, L. B. (Umea Univ., Sweden). Phys. Rev., 145: 999-1000(May 27, 1966).

It was suggested previously that the existence of a universal length implies space-time inhomogeneities which might be detected by comparing the results of colliding beam and laboratory scattering experiments. It is argued that the same inhomogeneities should show up in the velocity dependence of the lifetimes of unstable particles. This could be used for an experimental test of the hypothesis. (auth)

28153 GRAVITATIONAL COLLAPSE AND RELATIVISTIC MAGNETOHYDRODYNAMICS. Cocke, W. J. (Aerospace Corp., El Segundo, Calif.). Phys. Rev., 145: 1000-4(May 27, 1966).

Einstein's field equations for a perfect fluid coupled to a frozen-in magnetic field are studied in the high-density limit of gravitational collapse. The assumption of infinite electric conductivity is used to integrate Maxwell's equations and the fluid entropy conservation equation; and the integrals obtained show that there are certain general, physically reasonable conditions under which the electromagnetic energy density can become much larger than the fluid energy density as the collapse proceeds, even when the electromagnetic field was initially very weak. The widest possible range of cases is discussed under the assumption that the equation of state is asymptotically linear. Ways in which the hypotheses used might go wrong are mentioned. (auth)

28154 ROSS-SCHIFF ANALYSIS OF A PROPOSED TEST OF GENERAL RELATIVITY: A CRITIQUE. Shapiro, Irwin I. (Massachusetts Inst. of Tech., Lexington). Phys. Rev., 145: 1005-10(May 27, 1966).

Using a model of circular coplanar orbits and an analysis

accurate to first order in the sun's gravitational radius, Ross and Schiff discussed the recent proposal to test general relativity by measuring round-trip travel times of radar pulses transmitted from the earth towards an inner planet. Their main conclusion, that such measurements would be sensitive to a nonlinear term in Einstein's theory, is found to be invalid. Since first-order differences between Newtonian and Einsteinian orbits are well known to depend on a nonlinear term in the metric, one might expect the round-trip travel times also to depend in first order on such a term. Curiously, this expectation is not realized for circular orbits. When expressed as a function solely of clock readings, the first-order formula for travel time in the circular-orbit model is strictly independent of the nonlinear term. Even were the combined use of radar-pulse travel times and the results of "exact" optical measurements envisioned, their sensitivity to this nonlinear term would be masked almost completely by unavoidable uncertainties in the estimates of other unknown parameters such as the mass of the sun. For noncircular orbits, however, the travel-time measurements will be noticeably sensitive to this nonlinear term through its effect on the advance of the perihelion. In addition to reexamining the circular-orbit model, the operational procedures that were developed for testing general relativity with data obtained from actual planetary observations are described. These data cannot be expected in the near future to provide a significant test of more than the first-order influence of solar gravity on radar-pulse travel times and the non-Newtonian advance of Mercury's perihelion, as was previously pointed out. (auth)

28155 HAMILTONIAN FORMULATION OF ACTION AT A DISTANCE IN ELECTRODYNAMICS. Nigam, B. P. (Arizona State Univ., Tempe). Phys. Rev., 145: 1026-34 (May 27, 1966).

The hamiltonian formulation of the Wheeler-Feynman theory of action at a distance in classical electrodynamics as carried out by Kerner, who has derived the nonrelativistic classical hamiltonian for the interaction of two spinless charged particles interacting by means of half-retarded plus half-advanced potentials, was generalized to obtain the corresponding relativistic classical hamiltonian to order e^4 and c^{-4}. Using the procedure of Daughaday and Nigam, the classical hamiltonian is transformed into the quantum-mechanical hamiltonian operator. (auth)

28156 ELECTRON SELF-ENERGY IN INTENSE PLANE-WAVE FIELD. Eberly, Joseph H. (Univ. of Rochester, N. Y.); Reiss, Howard R. Phys. Rev., 145: 1035-40(May 27, 1966).

The self-energy for an electron in an intense external plane-wave field is calculated in perturbation theory. It is demonstrated that the Feynman-Dyson perturbation series may be summed exactly and in closed form with the neglect of the small self-field effects. In order to facilitate the summation, an earlier method is modified to accommodate off-mass-shell momenta for the electron. The momentum-conserving part of the full Green's function is then defined and computed. By adopting Volkov boundary conditions, which specify the plane-wave field to be monochromatic, a mass shift is obtained which agrees with the shift discussed by Sengupta and others. The mass shift is discussed briefly in connection with the question of a frequency shift in strong-field Compton scattering; and the momentum dependence leads to some remarks on the relation between the present calculation and its analog in ordinary quantum electrodynamics. (auth)

28157 DENSITY OPERATORS FOR COHERENT FIELDS. Titulaer, U. M.; Glauber, R. J. (Harvard Univ., Cambridge, Mass.). Phys. Rev., 145: 1041-50(May 27, 1966).

The forms which the conditions for coherence impose upon the density operators for electromagnetic fields are studied. It is shown that all fields possessing first-order coherence may be regarded as ones in which only a single mode is excited; this mode need not, however, be a monochromatic one. The higher order coherence conditions may be regarded as specifying certain moments of the distribution of the number of photons in the single excited mode. Full coherence, in particular, is shown to require that the number of photons present follow a Poisson distribution. The class of fields which possess full coherence is shown to be larger than the class of eigenstates of the annihilation operators. The unique character of the eigenstates, on the other hand, is demonstrated by means of a number of simple theorems. (auth)

28158 PROPERTIES OF THE PAULI MATRICES A, B, C AND THE CONJUGATION OF CHARGE. Longe, P. (Univ. of Maryland, College Park). Physica, 32: 603-10 (Mar. 1966).

The usual properties of the matrices A, B, and C introduced by Pauli are established without making use of any expressions of these matrices as functions of the Dirac matrices, except if such expressions hold in all the representations. Moreover no special characters (such as hermiticity, unimodularity) are now required of them. Such a procedure is also applied to the matrices representing the Lorentz group in the spinor space. It is then possible to construct bilinear invariants having a very general form and containing implicitly the charge conjugation. (auth)

28159 LATE DEVELOPMENTS IN GENERAL RELATIVITY THEORY. Ehlers, Juergen (Univ. of Texas, Austin). pp 286-303 of Physikertagung 1965 Frankfurt (M)-Hoechst, Okt. 4-9. Plenarvortraege. Stuttgart, B. G. Teubner Verlagsgesellschaft mbH, 1965. (In German).

The present development of the general relativity theory is systematically described. The basic assumptions of the theory are given and some consequences drawn from these basic assumptions are discussed. Empirical proofs of the theory are given. (J.S.R.)

28160 QUANTUM THEORY OF THE GRAVITATIONAL FIELD AND THE PLANCK ELEMENTARY LENGTH. Treder, Hans-Juergen (Institut fuer Reine Mathematik, Berlin). pp 541-51 of Physikertagung 1965 Frankfurt (M)-Hoechst, Okt. 4-9. Plenarvortraege. Stuttgart, B. G. Teubner Verlagsgesellschaft mbH, 1965. (In German).

It is shown that each study for a synthesis for quantum theory and general relativity theory yields factual arguments that the unlimited validity of the three axioms of quantum field theory (the Lorentz-Minkowski metrics of space-time, the existence of definite vacuum, and the fulfillment of the Einstein causality principle) in the space of a general relativistic quantum field theory is very doubtful. (J.S.R.)

28161 FOUNDATION OF TRANSPORT EQUATIONS. Grossmann, S. (Univ., Marburg, Ger.). pp 37-42 of Physikertagung 1965 Frankfurt (M)-Hoechst, Okt. 4-9. Vorabdrucke von Kurzfassungen der Fachberichte. Stuttgart, B. G. Teubner Verlagsgesellschaft mbH, 1965. (In German).

Modern methods in the derivation and establishment of transport equations in microscopic systems are reported. These methods permit an expansion of the Boltzmann theory to systems with greater density and at lower temperatures than in the classical Boltzmann gases. In particular they make possible a general representation of transport coefficients through generalized susceptibilities (linear response theory). Quantum systems with their typical symmetry correlations were detectable with these methods and the applicability of the general transport equations was expanded. The derivations can open many problems in the establishment of microscopic stochastic equations from the quantum mechanical equations as the spectrum of the hamiltonian operators leading to irreversible behavior, the connection with ergodic theory, and the establishment of statistical operators of equilibrium systems. (tr-auth)

28162 GENERAL RELATIVISTIC DYNAMICS AND MACH'S PRINCIPLE. Hoenl, H. (Univ., Freiburg i. B.). pp 125-30 of Physikertagung 1965 Frankfurt (M)-Hoechst, Okt. 4-9. Vorabdrucke von Kurzfassungen der Fach-

berichte. Stuttgart, B. G. Teubner Verlagsgesellschaft mbH, 1965. (In German).

The method of the observation field, the force concept of the general relativity theory, application to the Thirring effect (rotating masses), application to the Mach principle, and classical dynamics of spin particles are considered and represented. (tr-auth)

28163 FERMION DESCRIPTION OF A HEISENBERG SPIN SYSTEM. Tomita, K. (Atomic Energy Research Establishment, Harwell, Eng.). Proc. Phys. Soc. (London), 88: 293-310(June 1966).

To avoid the complications associated with the commutation relations for spin operators inherent in the more usual approaches to a theory of the Heisenberg model, Pratt and Puff introduced an electronic model in which a strong repulsion between electrons caused the electron system to simulate the Heisenberg model, but met with difficulties in treating the strong repulsion as a perturbation. It is shown how the theory may be made sound by a more rigorous treatment of the strong repulsion. The results obtained in the lowest order are shown to be equivalent to Weiss molecular field theory for the single-particle Green function and the random phase approximation to spin-wave theory for the two-particle Green function. The S^2 sum rule is shown to be satisfied in both the high- and low-temperature limits, but not at intermediate temperatures and a method of renormalization based on this sum rule is suggested. (auth)

28164 RADIATION COORDINATES IN GENERAL RELATIVITY. Florides, P. S. (Trinity Coll., Dublin, Dublin Inst. for Advanced Studies); McCrea, J.; Synge, J. L. Proc. Roy. Soc. (London), Ser. A, 292: 1-13(May 3, 1966).

A system of coordinates (called radiation coordinates), which may be useful in discussing problems of gravitational radiation is presented. Starting with a general system of coordinates x^i in curved space-time, an assigned timelike curve C, and an orthonormal tetrad assigned along C, the radiation coordinates $\tilde{x}^a$ of any event P are defined by a formula involving the world function. In radiation coordinates the equation of any null cone, drawn from an event $\tilde{x}^{a'}$ on C into the future, has the Minkowskian form $\eta_{ab}(\tilde{x}^a - \tilde{x}^{a'})(\tilde{x}^b - \tilde{x}^{b'}) = 0$, $\eta_{ab} = \mathrm{diag}\,(1,1,1,-1)$. The metric tensor satisfies the coordinate conditions $\tilde{g}_{ab}(\tilde{x}^b - \tilde{x}^{b'}) = \eta_{ab}(\tilde{x}^b - \tilde{x}^{b'})$, where $\tilde{x}^{b'}$ are regarded as functions of $\tilde{x}^b$, viz., the coordinates of the point of intersection of C with the null cone drawn into the past from $\tilde{x}^b$. Continuity on C of the Jacobian matrix of the transformation $x \to \tilde{x}$ is ensured by demanding the constancy of the components on the tetrad of the unit tangent vector to C. Continuity of the second derivatives of the transformation cannot be obtained except in very special circumstances. If space-time is flat, C a geodesic, and the orthonormal tetrad transported parallelly along C with the fourth vector tangent to C, then radiation coordinates reduce to the usual Minkowskian coordinates having C for time axis. (auth)

28165 DEVIATION FROM SIMPLE QUANTUM ELECTRODYNAMICS. Blumenthal, R. B.; Ehn, D. C.; Faissler, W. L.; Joseph, P. M.; Lanzerotti, L. J.; Pipkin, F. M.; Stairs, D. G. (Harvard Univ., Cambridge, Mass.). pp 368-77 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

The photoproduction on carbon of wide-angle electron-positron pairs was investigated in the energy range from 1 to 6 Bev. The experimental results do not agree with the predictions of quantum electrodynamics for pair production; they suggest a breakdown of the theory or the presence of other processes. (G.O.Y.)

28166 COREPRESENTATIONS OF MAGNETIC POINT GROUPS. Cracknell, Arthur P. (Univ. of Singapore). Progr. Theoret. Phys. (Kyoto), 35: 196-213(Feb. 1966).

The well-established theory due to Wigner of the corepresentations of nonunitary groups is applied to the magnetic point groups and the results are tabulated. The equivalence of the theory of the corepresentations of the grey groups to the conventional treatment of time-reversal symmetry in space groups is also considered. (auth)

28167 RELATIVISTIC MOTION OF PARTICLES IN A SCALAR FIELD. Mirianishvili, M. M. (Tbilisi State Univ., Georgian SSR). Soobshch. Akad. Nauk Gruz. SSR, 41: 293-300(Feb. 1966). (In Russian).

Making use of the Hamilton-Jacoby approximation, Werle introduced the concept of effective potential into the classical relativistic theory of the motion of particles in scalar and vector fields. This concept makes it possible to describe relativistic effects by means of nonrelativistic equations; in the case of electrostatic and mesostatic vector fields the relativistic effects cause additional attraction, and the scalar fields cause additional repulsion. The motion of particles in a scalar field was previously examined, and it was found that in a certain area the relativistic effects actually transform the attraction into repulsion. This paradoxical conclusion was closely studied by investigating the relativistic motion of a particle in a four-scalar field and redefining the concept of effective potential. It was concluded that the main difference between the four-scalar and the four-vectorial fields is due to the difference in the form of the conservation of energy law. The derivation carried out also clarifies the error in Werle's equation. (TTT)

28168 ORTHOGONAL DECOMPOSITION OF AXI-SYMMETRIC STATIONARY SPACETIMES. Kundt, Wolfgang; Truemper, Manfred (Univ., Hamburg). Z. Phys., 192: 419-22(1966).

It is shown that for a wide class of field equations the orbits of the isometry group defining axial symmetry and stationarity admit orthogonal 2-surfaces. The field equations covered by this result include those of a perfect fluid. (auth)

28169 QUANTUM FLUCTUATIONS, MASTER EQUATION AND FOKKER-PLANCK EQUATION. Risken, H.; Schmid, C.; Weidlich, W. (Technische Hochschule, Stuttgart). Z. Phys., 193: 37-51(1966).

In order to describe quantum fluctuations a general method is developed, which also may be applied to nonstationary systems as well as to states far from thermodynamic equilibrium. After a concise derivation of the master equation quantum mechanically determined dissipation and fluctuation coefficients are introduced, for which several theorems and relations are given. By using these coefficients there is set up a general Fokker-Planck equation for the diffusion of the statistical operator due to quantum fluctuations. (auth)

28170 BASIC CONCEPTS IN QUANTUM MECHANICS. Kompaneyets, Alexander S. New York, Reinhold Publishing Corporation, 1966. 158p. Chapman and Hall Ltd., London.

Translated by Scripta Technica, Inc.

A clear elementary presentation of the basic notions of quantum mechanics, using no calculus or higher mathematics, is given. Discussions are presented of geometric and wave optics, the uncertainty principle, quantum laws of motion, motion of electrons in an atom, electron spin, atomic structure, electrons in crystals, quantized fields, and Dirac's theory. (M.J.T.)

28171 QUANTUM THEORY OF ANGULAR MOMENTUM. A COLLECTION OF REPRINTS AND ORIGINAL PAPERS. Biedenharn, L. C.; Van Dam, H. (eds.). Perspectives in Physics, A Series of Reprint Collections. New York, Academic Press, 1965. 338p.

Papers are presented tracing the development of the quantum theory of angular momentum from its origins in atomic and nuclear spectroscopy. Two previously unpublished papers are included: Wigner's "On the Matrices Which Reduce the Kronecker Products of Representations of S. R. Groups" and Schwinger's "On Angular Momentum." Seventeen reprints are included, in German and English, on quantum mechanics of the magnetic electron; a deduction from Schroedinger theory for term structure; hyperfine structure of Li^+; representations of finite groups; theory

of complex spectra, nuclear levels and the Casimir operator; matrix elements of noncentral nuclear forces; symmetry properties of the Racah, Wigner, and Clebsch-Gordan coefficients and their applications; representations of the rotation group. Algebraic tables of the $J = \frac{1}{2}$, 1, $\frac{3}{2}$, and 2 Wigner coefficients are given. 254 references. (auth)

Low Temperature Physics

Refer also to abstracts 28256 and 28633.

28172 (BNL-10147) A REVIEW OF HIGH-FIELD SUPERCONDUCTING LENSES. Paskin, Arthur (Brookhaven National Lab., Upton, N. Y.). [1966]. Contract AT(30-2)-Gen-16. 32p. (CONF-660312-6). Dep. mn. CFSTI $2.00 cy, $0.50 mn.

From Nederlands Atoomforum, Utrecht.

The various successful magnets that were developed and built at Brookhaven were used to illustrate what can be done today using superconducting-magnet-technology. (M.O.W.)

28173 (IAE-1007) ISSLEDOVANIE SIL'NOTOCHNYKH VVODOV V ZHIDKII GELII. (Investigation of High-Current Inlet into Liquid Helium). Keilin, V. E.; Klimenko, E. Yu. (Institut Atomnoi Energii, Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). 1965. 24p. Dep. mn.

The conditions for the decrease of the speed of evaporation, dependent on the introduction, of high-flow liquid helium were investigated experimentally and theoretically. Inlets, cooled with evaporating helium, were examined basically. The calculations made and the experimental results were in good agreement. They indicate the weak dependence of the evaporation speed on the temperature of the thermal end of the outlet and on its geometric dimensions. A quantitative advantage was derived from the utilization of combined inlets (superconductors in good thermal and electrical contact with normal metals). (tr-auth)

28174 MAGNETIC FIELDS AND LOW-TEMPERATURE PHENOMENA. Halpern, Otto (American Express Co., Vienna). Acta Phys. Austr., 21: 305-11(1966).

A comparison is made between previously used thermodynamic expressions for magnetic contributions to functions like the free energy, with those now used. The formulas adopted lead to a new expression for the entropy determining e.g., the cooling obtained by adiabatic demagnetization. Similarly the formula is used in application to the critical points in superconductivity, and particularly for a reinterpretation of the view of the so-called intermediate state. (auth)

28175 CRITICAL CURRENT ENHANCEMENT AND DEGRADATION DUE TO HYSTERESIS IN NONIDEAL TYPE II SUPERCONDUCTORS IN AXIAL MAGNETIC FIELDS. LeBlanc, M. A. R.; Belanger, B. C. (Univ. of Southern California, Los Angeles). Appl. Phys. Lett., 8: 291-4(June 1, 1966).

The initial configuration of magnetic flux which can lead to considerable variation of the critical conduction current in nonideal type II superconductors in static longitudinal magnetic fields is reported. Enhanced critical currents are always associated with the generation of a strong axial paramagnetic magnetization. Quenching as the current is isothermally decreased from an enhanced value is also reported. This phenomena was observed in wires of Nb_3Zr. (B.G.D.)

28176 SUPERCONDUCTING MAGNET DEVELOPMENT. I. Laverick, Charles. Argonne Nat. Lab. Rev., 3: 11-20(Jan. 1966).

Advantages of superconducting magnets are summarized. Properties of the three classes of superconductors are discussed. Materials used for superconducting magnets, including NbZr, NbTi, and Nb_3Sn, are considered giving variation of critical current with magnetic field for various commercial samples. Problems involved in the design and operation of early magnets are reviewed. Effects of copper coatings on NbZr wire are described. Configurations using cables and multiple conductors are considered. (M.J.T.)

28177 ELECTRON PAIR THEORY OF SUPERCONDUCTIVITY. Saunders, G. A. (Univ. of Durham, Eng.). Contemp. Phys., 7: 192-209(Feb. 1966).

During the last decade an acceptable explanation of superconductivity at the atomic level was developed. The physical principles underlying the electron pair theory are described. Experimental verification of the theory and its application to real superconductors are examined. (auth)

28178 NEW SUPERCONDUCTORS. Rose-Innes, A. C. (Manchester Coll. of Science and Technology, Eng.). Contemp. Phys., 7: 135-51(Dec. 1965).

It has recently been realized that there is more than one kind of superconductor, and superconducting metals and alloys are recognized as being either "type-1" or "type-2." The "new" type-2 superconductors can exist in a state which allows them to carry resistanceless currents even in very strong magnetic fields, and they are used to construct very powerful electromagnets. The properties of type-2 superconductors, why very strong magnetic fields are required to drive them normal and why under certain circumstances they can carry large lossless currents are described. (auth)

28179 ^{3}He DILUTION REFRIGERATOR. Hall, H. E.; Ford, P. J.; Thompson, K. Cryogenics, 6: 80-8(Apr. 1966).

The design, construction, and performance of a continuous refrigerator based on the reversible dilution of liquid helium-3 with liquid helium-4 are described. The lowest temperature attained is 0.065 ± 0.005°K, deduced from the susceptibility of cerium magnesium nitrate. Helium-3 is circulated at a maximum rate of 3.3×10^{-5} mole/s, giving a cooling power of 250 erg/s at 0.15°K falling to 40 erg/s at 0.10°K. The performance is compared with theoretical expectation and the factors limiting it are discussed. (auth)

28180 KAPITZA RESISTANCE FOR A HELIUM FILM. Montgomery, H.; Matthew, P. A. Cryogenics, 6: 94-8 (Apr. 1966).

Experiments are described which investigate the temperature distribution within a vapor pressure bulb containing superfluid helium. It is found that the helium may be several millidegrees warmer than the surrounding walls if the bulb is in a vacuum, but that the temperature difference is greatly reduced if the bulb is surrounded by exchange gas. To explain this effect in detail one must assume that there is a Kapitza thermal resistance between a saturated helium film and its substrate: this resistance was measured at 1.6°K for a film flowing over copper, and its value is found to be within 5 per cent of the value for the bulk liquid. (auth)

28181 DISRUPTION OF SUPERCONDUCTIVITY IN AN ALLOY WITH A DISPERSE SUPERCONDUCTING PHASE. Romanov, E. P.; Sadovskii, V. D.; Volkenshtein, N. V.; Smirnov, L. V. (Inst. of Physics of Metals, Academy of Sciences, USSR). Fiz. Metal. Metalloved., 21: 17-20(Jan. 1966). (In Russian).

The disruption of superconductivity in an alloy of Zr with 4 wt % Nb following the decomposition of the supersaturated solid solution in a longitudinal magnetic field generated by means of a superconducting solenoid at 4.2°K was investigated. The current was introduced at an increasing rate into the specimens by means of a semiconductor amplifier and the disruption of superconductivity was recorded by means of an automatic-recording millivoltmeter. The transition from superconducting to normal state was found to be abrupt in the absence of the magnetic field and increasingly smooth the greater the intensity of the magnetic field applied. Plotting of the curves of electric resistance as a function of the current introduced revealed that the disruption of superconductivity occurs over a wide range of the values of the current and magnetic field. Apparently,

various sectors of the superconducting circuit differ in the dependence of their critical current on the intensity of the magnetic field. Electric resistance increased with increasing magnetic-field intensity. On the whole, the character of the transition curves indicated that disruption of superconductivity by current in a longitudinal magnetic field occurred gradually, because of the successive elimination of the superconducting state of individual sectors of the superconducting circuit. Although specimens in fields of the order of 20 kOe became markedly heated, some of their sectors still remained in superconducting state. (ATD)

28182 ON EINSTEIN-BOSE CONDENSATION. Casimir, H. B. G. (Philips' Gloelampenfabrieken, Eindhoven, Netherlands). Koninkl. Ned. Akad. Wetensch., Proc., Ser. B, 69: 223-9(1966).

A more precise meaning is given to the statement that a superfluid or superconducting phase is characterized by a macroscopically coherent many-particle wave function or that the system is in a macroscopic quantum state. Einstein-Bose condensation is considered in a cube, a long prism, in a cube with impurities, and with tunneling. The calculations show that in Einstein-Bose condensation a difference should be drawn between the behavior of the thermodynamic functions and the coherence phenomenon. For a body of sufficient size the thermodynamic functions will not be affected by changes of shape or by impurities and barriers. (J.F.P.)

28183 MAGNETIZATION CURVES AND RESISTANCE TRANSITIONS OF SUPERCONDUCTING LEAD ALLOYS. Druyvesteyn, W. F. (Technical Univ., Eindhoven, Netherlands). Philips Res. Rep. Suppl., No. 2, 1-121(1966).

The magnetization curves and the resistance transitions of superconducting lead and lead alloys are discussed. Special attention is paid to the influence of foreign atoms or lattice defects. This is done in order to examine the extent to which the behavior of superconducting alloys is governed by the properties of homogeneous alloys, e.g., by the residual resistivity, or by the deviations from homogeneity. Some specific properties of hard and soft superconductors are briefly discussed. The magnetization curves of lead alloys in a longitudinal and transverse field are examined. (auth)

28184 ANGULAR DEPENDENCE OF THE SURFACE SUPERCONDUCTING CRITICAL FIELD. Yamafuji, K.; Kusayanagi, E.; Irie, F. (Kyushu Univ., Fukuoka, Japan). Phys. Lett., 21: 11-13(Apr. 15, 1966).

A simple analytic formula is derived for the angular dependence of surface superconducting critical fields in thick films by solving the linearized Ginzburg-Landau equation. The angular dependence and the value of initial drop agree well with the observed data. (auth)

28185 INFLUENCE OF SURFACE CONDITION ON THE CRITICAL CURRENTS ABOVE H_{c2} IN A SUPERCONDUCTING TANTALUM–NIOBIUM ALLOY. Bellau, R. V. (General Electric Co. Ltd., Wembley, Eng.). Phys. Lett., 21: 13-16(Apr. 15, 1966).

Surface currents above H_{c2} fit empirical expressions $I_c \propto \{H_0(\theta) - H\}^n$. $H_0(\theta)$ depends on temperature and angle θ between H and surface. Improving surface polish lowers n from 5 or more to 2 (theory predicts $\frac{3}{2}$). Temperature variation of I_c is in accordance with theory. (auth)

28186 NUCLEAR SUSCEPTIBILITY OF ^{3}He IN DILUTE SOLUTION IN LIQUID ^{4}He. Husa, D. L.; Edwards, D. O.; Gaines, J. R. (Ohio State Univ., Columbus). Phys. Lett., 21: 28-30(Apr. 15, 1966).

The nuclear susceptibility of ^{3}He in liquid ^{4}He was measured between 0.35 and 1.3°K for concentrations up to 15%. The results are very close to the ideal Fermi-Dirac values calculated with $m^* = 2.5\ m_3$, the effective ^{3}He–^{3}He interaction being too small to detect for concentrations below 10%. (auth)

28187 LOSSES IN TYPE II SUPERCONDUCTORS. Baixeras, J. (L.C.I.E., Fontenay-aux-Roses, France). Phys. Lett., 21: 30-1(Apr. 15, 1966). (In French).

Experimental results on losses in type-II superconductors in passing continuous currents through samples of Nb, Nb–25% Zr, and Pb–In. (tr-auth)

28188 NUCLEAR SPIN RELAXATION AND MOLECULAR REORIENTATION IN METHANE AT LOW TEMPERATURES. De Wit, G. A.; Bloom, M. (Univ. of British Columbia, Vancouver). Phys. Lett., 21: 39-41(Apr. 15, 1966).

The spin-lattice relaxation time has been measured as a function of temperature down to 1.2°K in methane and its deuterated modifications. The implications of these measurements with respect to the low temperature phase transitions in methane are discussed. (auth)

28189 NONLINEAR ELECTRODYNAMICS OF SUPERCONDUCTING FILMS. Rose, K.; Sherrill, M. D. (General Electric Research and Development Center, Schenectady, N. Y.). Phys. Rev., 145: 179-88(May 6, 1966).

Microwave-transmission measurements at 9.4 Gc over a wide range of incident power were used to study the nonlinear electrodynamics of thin superconducting films. By measuring the amplitude and phase of the fundamental transmitted field, the contributions of superelectrons and normal electrons to the electrodynamics of the films were determined. In low microwave fields the nonlinear behavior of the films can be attributed to the breakup of superconducting pairs in agreement with the Ginzburg-Landau theory. In high microwave fields, regions of normal resistance appear through which a d-c bias current cannot avoid passing. Most of the third-harmonic power is generated by these resistive regions. (auth)

28190 SUPERCONDUCTIVITY OF Sn–Zn EUTECTIC ALLOYS. Lutes, O. S.; Clayton, D. A. (Honeywell Research Center, Hopkins, Minn.). Phys. Rev., 145: 218-24(May 6, 1966).

An experimental study was made of the superconducting transitions in Sn–Zn eutectic alloys in the temperature range 3.0–3.7°K, employing magnetization measurements on spherical samples. The samples were about 4 mm in diameter, and the laminar spacing varied from 1 to 8μ depending on the speed with which the parent ingot had been cooled from the melt. The measurements showed magnetic isotherms approaching those of a type-I superconductor, but with frozen flux of varying degree. The critical-field-versus-temperature relation was similar to that of pure Sn, providing evidence that the laminations behave like a continuous superconducting material. The transition temperature T_c was found to decrease with decreasing laminar spacing. This effect was compared quantitatively with the predictions of proximity-effect theory. The two significant theoretical parameters derived from the data were ρ_s, the effective resistivity ratio of the Sn-rich phase, and T_{cn}, the effective transition temperature of the Zn-rich phase. The large-spacing T_c data indicated an effective ρ_s of about 0.12, in reasonable agreement with the expected magnitude. At smaller spacing the experimental T_c was higher than expected. Alternatively stated, T_{cn} was 2.7°K, which is larger than the accepted Zn transition temperature 0.9°K. (auth)

28191 ONE-DIMENSIONAL SOLUTIONS OF THE GINZBURG-LANDAU EQUATIONS FOR THIN SUPERCONDUCTING FILMS. Arp, V. D.; Collier, R. S.; Kamper, R. A.; Meissner, H. (National Bureau of Standards, Boulder, Colo.). Phys. Rev., 145: 231-6 (May 6, 1966).

Solutions to the Ginzburg-Landau equations were obtained for plane films in a longitudinal magnetic field. Only symmetrical one-dimensional solutions were generated, but without restrictive assumptions on the Ginzburg-Landau parameter κ or the effective wave function ψ. The critical field was calculated from these solutions as a function of κ and the ratio of film thickness d to penetration depth. Curves are given to show how the behavior of films at the critical field depends on the various parameters involved. The computer solutions join smoothly onto those derived in the limit $\psi \to 0$. The limit of validity of these computer

solutions in the light of the vortex solutions of Abrikosov and the asymmetrical solutions of Saint James and de Gennes is determined, and a "phase diagram" in the (κ,d) plane for all types of solutions is suggested. (auth)

28192 LONGITUDINAL CRITICAL CURRENT IN TYPE-II SUPERCONDUCTORS. Boyd, R. G. (Univ. of California, Berkeley). Phys. Rev., 145: 255-7(May 6, 1966). (UCRL-16519).

The longitudinal critical current of a bulk type-II superconductor near the transition field H_{c2} was calculated from the Ginzburg-Landau equations via a simple extension of Abrikosov's treatment of the mixed state, valid when the self-field of the current can be considered negligible compared with the external field. The critical current is given by $(4\pi J_c/c) = (2/3)^{\frac{1}{2}}(H_{cb}/\lambda)(1 - H/H_{c2})^{\frac{1}{2}}/\beta(1 - 1/2\kappa^2)$. This expression should be obeyed very near H_{c2} by small wires with strong pinning and with surfaces properly treated to inhibit surface currents. (auth)

28193 GINZBURG-LANDAU PARAMETER OF FILM SPECIMENS. Chang, G. K.; Serin, B. (Rutgers Univ., New Brunswick, N. J.). Phys. Rev., 145: 274-9(May 6, 1966).

Results of magnetization measurements on thin superconducting films in magnetic fields transverse to the plane of the film are reported. The temperature dependence of the field, H_c, which causes a transition into the normal phase was determined for specimens of pure indium and tin as well as for alloy films containing these metals as solvents. The data are used to define a Ginzburg-Landau parameter $K_1(T)$, and are compared with various functional forms for the temperature dependence of this parameter that were proposed. By extrapolating $K_1(T)$ to the transition temperature, the usual Ginzburg-Landau parameter K is obtained. Values of the electron mean free path are also deduced from measurements of the residual resistance ratio in the normal phase. For the indium-based specimens the dependence of K on electron mean free path is in good agreement with the theoretical expression of Gor'kov. It is concluded that no single functional form for the dependence of K_1 on temperature can describe the data. Rather, the form varies continuously as the electron mean free path changes. In particular, in the pure limit the transition field varies appreciably more rapidly than theoretical predictions based on the microscopic theory of superconductivity. (auth)

28194 LOW-TEMPERATURE STRUCTURAL TRANSFORMATION IN V_3Si. Batterman, B. W.; Barrett, C. S. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 145: 296-301(May 6, 1966).

The experimental observations on the low-temperature martensitic-like transformation of the compound superconductor V_3Si are discussed in detail. Evidence is presented showing that the transformation from the high-temperature cubic β-tungsten phase to a tetragonal structure occurs at temperatures above the superconducting transition T_c (17.0°K). The detailed behavior of the transformation can vary between specimens, most probably because of deviations from exact stoichiometry. In high-resistance-ratio specimens, the transformation to tetragonal is complete at $T_m = 21.0 \pm 0.5$°K with a c/a ratio increasing continuously from unity and reaching a maximum value of 1.0024 within 0.1°K of T_c. The volume of the unit cell remains constant to better than one or two parts in 10^4 in both the cubic and tetragonal phases below 30°K. No further change in c/a occurs as the temperature is lowered, and hysteresis effects are never observed. Evidence is presented which leads to the conclusion that the transformation is of second order. The results together with Testardi's ultrasonic measurements imply that the transformation is a result of a general softening of the lattice as a temperature is lowered, and in particular is triggered at T_m by the near-vanishing of the restoring force for shear in a [1$\bar{1}$0] direction on a (110) plane. The structural transformation is not necessarily a precursor of superconductivity, but it is most probably due to the large temperature dependence of the elastic properties that leads to both phenomena. (auth)

28195 DIRECT EVIDENCE OF HYSTERESIS IN SUPERCONDUCTORS RESULTING FROM SURFACE PROPERTIES. Bertman, B.; Schweitzer, D. G.; Lipschultz, F. P. (Brookhaven National Lab., Upton, N. Y.). Phys. Lett., 21: 260-1(May 15, 1966). (BNL-9916).

Niobium samples were wetted with lead. Hysteresis below H_{c2} was reduced at all fields independent of whether the Pb coating was in the normal or superconducting state. An interpretation is given in terms of surface currents. (auth)

28196 ENHANCEMENT OF THE MAGNETIC REVERSIBILITY OF A NON-IDEAL TYPE II SUPERCONDUCTOR BY SURFACE CONTAMINATION. Leblanc, M. A. R. (Aerospace Corp., Los Angeles). Phys. Lett., 21: 266-7(May 15, 1966).

Nonmetallic impurities can enhance the magnetic reversibility of a nonideal type II superconductor while leaving the critical current unchanged in axial magnetic fields. The local increase in the Ginzburg-Landau parameter k due to surface contamination depresses the critical current of a surface sheath in the mixed state. (auth)

28197 GEOMETRICAL DEPENDENCE OF FLUX PENETRATION AND TRAPPING IN SUPERCONDUCTING LEAD. Gottlieb, M.; Jones, C. K. (Westinghouse Electric Corp., Pittsburgh). Phys. Lett., 21: 270-1(May 15, 1966).

The influence of sample shape, magnetic field direction, and magnetic history on the penetration and trapping of magnetic flux in superconducting lead is investigated ultrasonically. (auth)

28198 SUPERCONDUCTIVITY OF METALLIC INDIUM ANTIMONIDE. Minomura, S.; Okai, B.; Nagasaki, H.; Tanuma, S. (Tokyo Univ.). Phys. Lett., 21: 272-3 (May 15, 1966).

Superconductivity was observed in metallic indium antimonide which is obtained by quenching at 170 kbar (above lead transition) and at room temperature to 77°K and 1 bar. The superconducting transition occurs at 4.8°K. (auth)

28199 DENSITY, COEFFICIENT OF THERMAL EXPANSION, AND ENTROPY OF COMPRESSION OF LIQUID ^{3}He UNDER PRESSURE BELOW 1.2 DEG K. Boghosian, Charles; Meyer, Horst; Rives, John E. (Duke Univ., Durham, N. C.). Phys. Rev., 146: 110-19(June 3, 1966).

The method of dielectric-constant measurement was used to determine the density of liquid ^{3}He under pressure between 0.07 and 1.2°K. It consists of measuring the resonant frequency of a tunnel-diode oscillator, the LC tank circuit of which includes a capacitor filled with the liquid ^{3}He. The tunnel-diode oscillator is kept at low temperature and is described and analyzed in detail. A description is given of the system necessary to keep the pressure of the ^{3}He constant. From the density measurements, the coefficient of thermal expansion and the entropy of compression are derived. The results are compared with earlier work. They are found to be thermodynamically consistent with the data obtained by other methods. (auth)

28200 PROPERTIES OF LIQUID ^{3}He IN THE TWO-BODY CORRELATION APPROXIMATION. [PART] I. Beck, Donald E. (Univ. of California, San Diego, La Jolla); Sessler, Andrew M. Phys. Rev., 146: 161-76(June 3, 1966). (UCRL-16524).

This is the first of two papers in which the low-temperature properties of liquid ^{3}He are to be calculated in the thermodynamically consistent "T-matrix" approximation. The set of coupled integral equations which are to be solved is exhibited in Sec. I. Section II is devoted to a preliminary zero-temperature calculation which employs the additional approximations of using separable potentials and a non-interacting spectral function to define the interaction of two particles in the medium: the $\langle T \rangle_0$ approximation. In this approximation a spectral function was obtained for the quasiparticles which are expected to display general features in common with those of the actual spectral function. Using this spectral function, the thermodynamic properties of the system are calculated and it was found that they compare favorably with those obtained in other calculations. (auth)

28201 ELECTROMAGNETIC ATTENUATION OF TRANSVERSE ULTRASOUND IN SUPERCONDUCTORS. Cullen, James R.; Ferrell, Richard A. (Univ. of Maryland, College Park). Phys. Rev., 146: 282-5(June 3, 1966).

The electromagnetic field set up by a transverse sound wave in a superconductor is screened out by the Meissner effect at temperatures below the transition temperature. Consequently the attenuation produced by electromagnetic coupling to the quasiparticles undergoes an abrupt decrease below the transition temperature. At sufficiently high frequencies the wavelength is short enough that this "rapid fall" is spread out over an appreciable temperature range. Thus measurements of the rapid fall in electromagnetic attenuation can provide a test for theories of the temperature dependence of screening in the superconducting state. Such measurements would have an advantage over the usual penetration-depth measurements in that they would study the response of the superconductor to a pure sinusoidal wave and not to an integrated superposition of such waves. But the analysis of the data requires a reliable theoretical expression for the transverse conductivity in the superconducting state. This is computed from the BCS theory along straightforward conventional lines. It is noted that the relevant coherence factors are the same as in the problem of nuclear spin relaxation, and that a logarithmic divergence due to the confluence of the singular density-of-states functions also enters in the present problem. In the present case this divergence is cut off by the finite frequency of the quasiparticle transition. For sufficiently high frequency this anomalous behavior of the transverse conductivity function can result in a "rapid rise" in the transverse attenuation immediately below the transition temperature, before the rapid fall sets in from screening. (auth)

28202 PRESSURE DEPENDENCE OF THE SUPERCONDUCTING TRANSITION TEMPERATURE OF dhcp AND fcc LANTHANUM. Smith, T. F. (Univ. of California, San Diego, La Jolla); Gardner, W. E. Phys. Rev., 146: 291-4(June 3, 1966).

The pressure dependence of the superconducting transition temperature of lanthanum was extended from 10 to 40 kbar. The sample becomes predominantly fcc above 23 kbar. The superconducting transition temperature increases continuously up to 9°K, with a possible discontinuity at the phase change and a definite change of slope. The behavior in the fcc phase differs in sign with that predicted from thermal-expansion measurements at atmospheric pressure. (auth)

28203 NEW RELATIONSHIP FOR SUPERCONDUCTORS. Grunzweig-Genossar, J.; Revzen, M. (Technion-Israel Inst. of Tech., Haifa). Phys. Rev., 146: 294-6(June 3, 1966).

A relation between the energy gap of superconductors at zero temperature and the slope of the critical magnetic field at the critical temperature is presented. Thermodynamical argument gives the dependence of this relation on the electronic specific heat near the critical temperature and an approximate formula for the latter is proposed. The conclusions are compared with experimental data. (auth)

28204 MICROWAVE PROPERTIES OF SUPERCONDUCTING ZINC IN THE ENERGY-GAP FREQUENCY REGION. Zemon, Stanley A.; Boorse, Henry A. (Columbia Univ., New York). Phys. Rev., 146: 309-16(June 3, 1966).

Microwave measurements of the relative power absorbed at resonance were made with a pure, polycrystalline zinc cavity. The data taken in a ^{3}He cryostat covered the frequency range from 50 to 75 kMc/sec and the temperature range from above the superconducting transition, T_c = 0.825 ± 0.008°K, down to 0.28°K. The results extrapolated to 0°K yield an energy gap of (3.01 ± 0.09) kT_c. The detailed comparison of R_s/R_n versus frequency showed good agreement in the Pippard limit with the BCS calculations scaled to the experimentally determined gap. A plot of R_s/R_n versus $h\nu/E_g(0)$ for zinc and aluminum showed that the law of corresponding states was valid to about 5%. (auth)

28205 INDIRECT INTERACTION INVOLVING IMPURITY STATES IN SUPERCONDUCTORS. Ganguly, B. N.; Upadhyaya, U. N.; Sinha, K. P. (National Chemical Lab., Poona). Phys. Rev., 146: 317-21(June 3, 1966).

A new theoretical mechanism of the observed increase in transition temperature T_c in some superconductors containing magnetic-element impurities in low concentration (e.g. Fe in Ti etc.) was suggested. In the concentration region of interest, these systems do not show the existence of any net localized magnetic moment. In the proposed mechanism, indirect Coulomb and exchange-type interactions were invoked involving BCS pairs and impurity electron pairs in the singlet states interacting through empty impurity states. The resulting interaction between BCS pairs is attractive. The theoretical expression for T_c, inclusive of the present (attractive) and earlier (repulsive) interactions, gives the right dependence as observed experimentally. The estimated strength of the interaction parameter J turns out to be of the order of 0.5 ev. Such mechanisms seem to be important for systems containing impurities which provide empty orbital states as visualized above. (auth)

28206 TEMPERATURE DEPENDENCE OF THE SUPERFLUID DENSITY IN He II NEAR T_λ. Clow, James R.; Reppy, John D. (Yale Univ., New Haven). Phys. Rev. Lett., 16: 887-9(May 16, 1966).

Liquid helium below the λ transition is characterized by the macroscopic occupation of a single quantum state. This state determines a superfluid velocity field, $\vec{v}_s$, throughout the liquid. There is a mass flow $\vec{j}_s$ associated with the superfluid velocity. The relation $\vec{j}_s = \rho_s \vec{v}_s$ defines the superfluid density, ρ_s. The superfluid density becomes equal to the total density, ρ, at absolute zero and decreases rapidly to zero at T_λ. A direct determination of the temperature dependence of ρ_s in the neighborhood of the transition is presented. (B.G.D.)

28207 EFFECT OF QUASIPARTICLE LIFETIME ON THE SUPERFLUID TRANSITION TEMPERATURE OF ^{3}He. Cohen, Roger W.; Abrahams, Elihu (Rutgers Univ., New Brunswick, N. J.). Phys. Rev. Lett., 16: 931-3(May 23, 1966).

Previous investigations on the superfluid transition temperature of ^{3}He have indicated this condensation can be brought about by forming a system of band-particle pairs in a manner similar to that considered in the Bardeen-Cooper-Schrieffer (BCS) theory of superconductors. These investigations have also indicated that the interaction is most favorable for angular momentum l = 2 pairing. However, these calculations did not include the effect of quasiparticle lifetimes and assumed that the momentum dependence of the bare-particle interaction potential $v(\vec{q})$ could be neglected. It is shown that if this assumption is not made, it is likely that the lifetime effect is sufficient to prevent an l = 2 state condensation and thereby reduce the transition temperature many orders of magnitude. (B.G.D.)

28208 ROTON EMISSION FROM NEGATIVE IONS IN HELIUM II. Rayfield, G. W. (Univ. of Pennsylvania, Philadelphia). Contract NSF-GP-5287. Phys. Rev. Lett., 16: 934-6(May 23, 1966).

Evidence is presented that in He II under a pressure greater than about 12 atm and at low temperatures, the maximum velocity of negative ions is limited by roton emission. Below this pressure the maximum velocity is determined by the point at which vortex-ring creation occurs. (B.G.D.)

28209 FULDE-FERRELL EFFECT IN TYPE-II SUPERCONDUCTORS. Gruenberg, Leonard W. (Massachusetts Inst. of Tech., Cambridge); Gunther, Leon. Phys. Rev. Lett., 16: 996-8(May 30, 1966).

By studying the effect of Pauli spin paramagnetism on the mixed state it is shown that for a pure superconductor, in which the ratio between the Gorkov upper critical field H_{c20} and the paramagnetically limited upper critical field H_p exceeds 1.28, a new kind of superconducting state can exist. At the nucleation field H_{c2}, the Cooper pairs find themselves in the lowest Landau orbit; in addition, they

have a drift velocity along the direction of the applied field. Although the orbital effects of a real magnetic field are detrimental to the Fulde-Ferrell state, such a state can exist in a type II superconductor. (B.G.D.)

28210 DETERMINATION OF THE COMPOSITION OF A ^{3}He–^{4}He MIXTURE FROM THE TRANSMISSION OF THERMAL NEUTRONS. Le Pair, C. (Kamerlingh Onnes Laboratorium, Leiden); Van Laar, B.; Loopstra, B. O. Physica, 32: 576-8(Mar. 1966).

A beam of monochromatic thermal neutrons — wavelength about 1 Å — is used to determine the composition of a mixture of ^{3}He and ^{4}He. The method offers a precision $\Delta X \leq 0.01$ over the complete concentration range. This is due to the difference in total neutron cross section, the latter is about a thousand times larger for ^{3}He than for ^{4}He. (auth)

28211 THEORY OF QUANTUM LIQUIDS. Goetze, W. pp 169-73 of Physikertagung 1965 Frankfurt (M)-Hoechst, Okt. 4-9. Vorabdrucke von Kurzfassungen der Fachberichte. Stuttgart, B. G. Teubner Verlagsgesellschaft mbH, 1965. (In German).

The latest results of the microscopic theory for He(II) were reported. The method of the hydrodynamic approximation of the Bogoliubov was discussed in particular. After consideration of the experimental results, the theory of the singular thermodynamic functions in phase transition in helium and in superconductors was reported. The latest results for the detection of the zero sound were described. (tr-auth)

28212 JOSEPHSON-TYPE SUPERCONDUCTING TUNNEL JUNCTIONS AS GENERATORS OF MICROWAVE AND SUBMILLIMETER WAVE RADIATION. Langenberg, D. N.; Scalapino, D. J.; Taylor, B. N. (Univ. of Pennsylvania, Philadelphia). Proc. IEEE (Inst. Elec. Electron. Eng.), 54: 560-75(Apr. 1966).

The use of Josephson-type superconducting tunnel junctions (two superconductors separated by a very thin insulating layer) as generators of radiation in the range 5 to 1000 GHz is discussed. To this end, the results of recent experiments on the observation of x-band radiation from such junctions are presented, along with a complete discussion of the theory of such junctions. Their potential use as detectors, voltage sources, and harmonic multipliers is also discussed. (auth)

28213 THERMODYNAMIC APPROACH TO SUPERFLUIDITY OF NUCLEAR MATTER. Khanna, K. M. (Indian Inst. of Tech., Kharagpur). Proc. Nat. Inst. Sci. India, 31A: 99-106(Mar. 1965).

Using the free-meson lattice model of the nucleus, an expression was derived for the difference of free energy between the normal and superfluid state of nuclear matter. In the normal state, attraction between nuclear particles predominates for lighter nuclei and for heavier nuclei there is contribution both from repulsion and attraction between nuclear particles. The kinetic energy of mesons(π) increases after the phase transition from the superfluid to the normal state. Energy conservation laws are maintained. (auth)

28214 FERROMAGNETISM IN A SUPERCONDUCTING ALLOY. Tsuzuki, Toshio (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 35: 183-95(Feb. 1966).

The possibility of coexistence of superconductivity and ferromagnetism in an alloy containing paramagnetic impurities, taking into account the spin-orbit interaction is investigated. The ferromagnetic ordering of the impurity spins takes place by virtue of exchange interaction with the conduction electrons and this ordering causes a spatial spin density of the conduction electrons. Gor'kov and Rusinov attempted to explain this problem by taking into account only the exchange interaction in a simple molecular field approximation. But they were not able to obtain consistently the phase diagram which is expressed in terms of temperature and the concentration of paramagnetic impurities. As one of the possible mechanisms of this phenomenon spin-orbit scattering by nonmagnetic impurities whose concentration is usually large is considered. Spin-orbit interaction increases the paramagnetic susceptibility of the electrons. Ferromagnetism is therefore weakened by this interaction. Furthermore the ferromagnetic sliding of the Fermi surface becomes less destructive of the Cooper effect because the electron spin is not conserved in spin-orbit interaction. It is shown that superconductivity and ferromagnetism can co-exist owing to the presence of a spin-orbit interaction with natural strength. (auth)

28215 INVERSE MAGNETIC FIELD READOUT FOR SUPERCONDUCTING MAGNET SWEEPS. Sullivan, Paul F. (Brown Univ., Providence). Rev. Sci. Instrum., 37: 730-2(June 1966).

A circuit is described for driving the abscissa of an X-Y recorder as the inverse of the magnetic field of a superconducting solenoid. The output is independent of the sweep rate for any sweep within the range of the instrument, and the error in the resultant plot is less than 0.5% of full scale for any 10 kG sweep of the magnet. (auth)

28216 ^{3}He CRYOSTAT FOR OPERATION TO 0.2 DEG K. Walton, D. (Oak Ridge National Lab., Tenn.). Rev. Sci. Instrum., 37: 734-6(June 1966). (ORNL-P-1720).

A cryostat is described which is capable of somewhat lower operating temperatures than was previously possible. This improvement was achieved through the use of a pumping line to the ^{3}He which is of larger than normal diameter, particularly at the low temperature end. Therefore, it is concluded that the major limitation in previous designs was the pressure drop in the pumping line. (auth)

28217 SUPERCONDUCTING BEARING. Daniels, B.; Matthews, P. W. (Univ. of British Columbia, Vancouver, Can.). Rev. Sci. Instrum., 37: 750-3(June 1966).

A superconducting bearing is described which depends for its operation on the conservation of the fluxoid in a closed loop of superconductor. In operation this bearing is identical with the well-known Beams magnetic suspension, except that the function of the servomechanism is performed automatically by the superconducting loop. The observed load characteristic of the bearing is compared with theoretical predictions, and a practical rotor is described. (auth)

28218 USE OF ALUMINUM IN SUPERCONDUCTING CABLES. Laverick, C.; Lobell, G. M.; Purcell, J. R.; Brooks, J. M. (Argonne National Lab., Ill.). Rev. Sci. Instrum., 37: 806-7(June 1966).

The feasibility of using Al wires in stranded superconducting cables was demonstrated by successfully fabricating a superconducing cable containing a substantial amount of Al, by constructing a superconducting magnet from the cable, and by operating the magnet in the fully stabilized mode. The magnet design permitted 100% internal liquid-helium cooling of the cable. A technique for calculating the current-carrying capacity of stabilized magnets of this type was developed, and the calculated and experimental results were found to be in close agreement. (M.J.T.)

28219 JOSEPHSON EFFECTS. Langenberg, Donald N.; Scalapino, Douglas J.; Taylor, Barry N. Sci. Amer., 214: No. 5, 30-9(May 1966).

Superconductivity is treated. The discussion includes the physical mechanisms for various effects considered such as the paired electron coherence for current flow without resistance, the d-c and a-c Josephson tunneling effects, the Meissner effect, abrupt increases in junction currents, and electromagnetic radiation from Josephson junctions. (J.F.P.)

28220 HIGH-FIELD, HIGH-CURRENT SUPERCONDUCTORS. Heaton, J. W. (Culham Lab., Cambridge, Eng.). Sci. Progr. (London), 54: 27-40(Spring 1966).

The mechanisms involved in high-field superconductivity are outlined, and methods are described for persuading materials showing this effect to carry large transport currents. The application of these superconductors in the creation of large magnetic fields is considered, and some of the problems of using high-field superconductors in practice are discussed. (auth)

28221 SUPERCONDUCTIVITY OF ALPHA URANIUM AND THE ROLE OF 5f ELECTRONS. Geballe, T. H. (Bell Telephone Labs., Murray Hill, N. J.); Matthias, B. T.; Andres, K.; Fisher, E. S.; Smith, T. F.; Zachariasen, W. H. Science, 152: 755-7(May 6, 1966).

A much sharper and lower superconducting transition was found for α-uranium than any reported previously. A model that explains the unusual volume dependence of α-uranium below 43°K and the unusual pressure dependence of its superconducting transition temperature is presented. (auth)

28222 STATIONARY TEMPERATURE DISTRIBUTION IN WEAK SUPERFLUID MIXTURES ^{3}He–^{4}He. Putkha, T. P. (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 11: 305-12(Mar. 1966). (In Ukrainian).

The results of an experimental study of the temperature field of weak isotopic mixtures of ^{3}He–^{4}He over a range of 0.5–2.17°K are presented. (auth)

28223 NONLINEAR AND NONLOCAL EFFECTS ON THE CRITICAL MAGNETIC FIELD FOR SUPERCONDUCTING In-Sn ALLOYED FILMS. Zhang, Yu-heng. Wu Li Hsueh Pao, 22: 341-59(Mar. 1966). (In Chinese).

Experimental studies of the critical magnetic field for indium films of different thicknesses alloyed with 2 at. % and 3 at. % of tin are reported, thus furnishing experimental data of $H_c \sim d$ for the case of finite electronic mean free path. From these data, it is concluded that the critical magnetic field of thin films can only be discussed in the light of the nonlocal, nonlinear theories, and that in the thin film limit, $H_c \propto d^{-\frac{1}{2}}$ for both pure and alloyed films. The local theories of London and of Ginzburg-Landau, and the nonlocal, linear theory of Ittner, are inapplicable. The erroneous conclusion of $H_c \propto d^{-1}$ made by certain authors, is due to incorrect analyses of experimental data. (auth)

28224 SUPERCONDUCTIVITY AND PHASE TRANSFORMATION IN TITANIUM ALLOYS. II. TITANIUM–CHROMIUM ALLOYS. Raub, Christoph Julius; Roeschel, Erich; Zwicker, Ulrich (Univ. of California, La Jolla. Forschungsinstitut fuer Edelmetalle, Schwaebisch Gmuend, Ger.). Z. Metallk., 57: 288-95(Apr. 1966). (In German).

Investigations concerning the influence of transformation processes on the superconducting behavior of titanium–chromium alloys showed that the transition temperature is appreciably lowered by the formation of metastable phases. The high-temperature and low-temperature $TiCr_2$ phases were not superconducting above 0.3°K. As in other titanium alloys the unstable β-phase showed a negative temperature coefficient of the resistance, which disappeared when α-Ti and $TiCr_2$ formed. Two minima in the concentration transition temperature curve of an arc-furnace melted and rapidly cooled small samples are explained by the formation of metastable phases. Similar behavior can be expected for other eutectoid forming additions, e.g., iron or manganese. (auth)

28225 CONTACT ACTION OF SUPERCONDUCTING DOUBLE FILMS OF Cu/Pb. Minnigerode, G. v. (Univ., Goettingen, Ger.). Z. Phys., 192: 379-408(1966). (In German).

The transition temperatures of superimposed films of copper and lead are measured at very low temperatures by means of a helium cryostat. The double films are condensed in situ inside the cryostat at 200°K, and have never been warmed up or brought to air before measuring. Careful measurements of the residual resistivities, film thicknesses and the choice of $l_n < l_s$ permit a comparison of the experimental results with the various theories of the proximity effect. The nonhomogeneous structure of the films and the surface scattering of the electrons were considered in a first approximation by the use of an effective resistivity. A fitting of the theoretical curves to the measured temperatures indicates either the existence of barrier layers between the two metals (in contradiction to the experiments of the proximity effect between two known superconductors) or copper being a superconductor itself with a low transition temperature. It is indicated that many experimental and theoretical problems are left unsolved in this field in contradiction to the judgement of others. (auth)

28226 PRODUCTION AND ANNEALING OF LATTICE DEFECTS AND THEIR INFLUENCE ON THE SUPERCONDUCTIVITY OF INDIUM AND THALLIUM. Hasse, Joerg; Seifritz, Walter (Technische Hochschule, Karlsruhe, Ger.). Z. Phys., 193: 52-64(1966). (In German).

The variation of the transition temperature with residual resistance of coldworked In and Tl shows a similar behavior as in dilute alloy experiments. Subsequent annealing removes lattice defects in distinct steps and restores the properties of pure samples at temperatures below 250°K. Some of the results can be interpreted in accordance with the model developed on alloy experiments. Values for the anisotropy parameter $\langle a^2\rangle_{In} = 0.02$ and $\langle a^2\rangle_{Tl} = 0.04$ were obtained. The interpretation of the "valence" effect and the influence of stress is discussed. (auth)

28227 SUPERCONDUCTIVITY OF NIOBIUM UNDER HIGH PRESSURE. Gey, W.; Heyden, G. v. (Technische Hochschule, Karlsruhe, Ger.). Z. Phys., 193: 65-72 (1966). (In German).

The influence of allside pressure on the transition temperature T_c of Nb is studied up to pressures of about $25(10)^3$ kp/cm^2. T_c goes through a flat minimum at about $5(10)^3$ kp/cm^2 and increases remarkably at higher pressures. The average slope of this increase between 10^4 kp/cm^2 and $2(10)^4$ kp/cm^2 equals $3.5(10)^{-5}$°K cm^2/kp. (auth)

28228 SUPERCONDUCTIVITY OF NIOBIUM UNDER UNIAXIAL STRESS. Lueders, Klaus (Technische Hochschule, Karlsruhe, Ger.). Z. Phys., 193: 73-5(1966). (In German).

The transition temperature of Nb-wires is increased by uniaxial stress. The average slope of the observed $T_c(\sigma)$-dependence equals $3.2(10)^{-5}$°K cm^2/kp. (auth)

28229 THEORY OF ABSORPTION OF SOUND IN SUPERCONDUCTORS WITH A CURRENT. Urushadze, G. I. (Inst. of Physics, Academy of Sciences, Georgian SSR). Zh. Eksp. Teor. Fiz., 50: 404-10(Feb. 1966). (In Russian).

The absorption of sound in impurity superconductors in which a current is flowing is studied using the methods of quantum field theory. The dependence of the absorption coefficient on temperature and on the quantity which determines the current in the sample is found. (auth)

28230 TRIPLET STATES IN A SUPERCONDUCTOR WITH MAGNETIC IMPURITIES. Akhtyamov, O. S. (Bashkirian State Univ., USSR). Zh. Eksp. Teor. Fiz., 50: 487-92(Feb. 1966). (In Russian).

The triplet states in a superconductor with magnetic impurities are considered for the magnetic as well as ferromagnetic phases. For the paramagnetic phase a second-order correction to the energy of the electron system is found and the indirect interaction between the impurity spins is determined. It is shown that the energy spectrum for a ferro-superconductor is defined by a cubic equation. This is shown to be due to complete removal of degeneracy with respect to direction of the pair spin. (auth)

28231 EXTRACTING ELECTRON BEAMS FROM A VACUUM INTO A GAS THROUGH A GAS-DYNAMIC WINDOW. Trokhan, A. M. Zh. Prikl. Mekh. Tekh. Fiz., No. 5, 108-11(Sept.-Oct. 1965). (In Russian).

While it is possible to use small capillary tubes to extract low-intensity electron beams from a vacuum system for injection into a gas at some higher pressure, for high-intensity beams the backflow of gas into the vacuum system constitutes a problem. In this connection it is customary to employ differential gas-dynamical "windows," where (for e) pumps are used to evacuate an intermediate chamber between vacuum and gas systems. A new design is discussed in which the pumps are replaced by a cryogenic apparatus reducing the flow of gas into the vacuum by condensation.

The intermediate space is filled with cold C_2 or water vapor serving as the refrigerant. This method has the advantages of being less bulky and of introducing no vibration into the gas confining system. Windows with a diameter of 15–20 mm were constructed, in contrast with diameters of 3–4 mm permitted by the use of pumps. Such a design is shown schematically. (ATD)

Neutron Physics

See also REACTOR TECHNOLOGY — Criticality Studies

Refer also to abstract 28673.

28232 (AE–226) THEORETICAL TIME-DEPENDENT THERMAL NEUTRON SPECTRA AND REACTION RATES IN H_2O AND D_2O. Purohit, S. N. (Aktiebolaget Atomenergi, Stockholm (Sweden)). Apr. 1966. 62p. Dep. mn.

Detailed results are presented for the time dependent spectra and the reaction rates for resonance detectors using several scattering models of H_2O and D_2O. The study was undertaken in order to interpret the integral time dependent neutron thermalization experiments in liquid moderators which were performed at AB Atomenergi. A brief mathematical formalism is presented for studying the moments problem using the one-dimensional Boltzmann equation. (M.O.W.)

28233 (GEAP–5079) DEVELOPMENT OF PULSED NEUTRON APPLICATION TO POWER REACTOR START-UP PROCEDURES. 15th Quarterly Progress Report, November 1, 1965–December 31, 1965. Meyer, P.; Garelis, E. (General Electric Co., San Jose, Calif. Vallecitos Atomic Lab.). Jan. 18, 1966. Contract AT(04-3)-189. 9p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

An investigation was made on the merits of using a pseudo random neutron source input to measure the impulse response function of a subcritical assembly. For this purpose a unique data aquisition system was designed and built to carry out the necessary cross correlation. The impulse response function is displayed continuously during a measurement. An analysis shows that this method gives in principle data identical to that obtained by the repetitive pulse neutron method. Work has progressed to the point where meaningful measurement can now be made. (auth)

28234 (INR–690/IX-A/R) MEASUREMENTS OF THE NEUTRON DIFFUSION PARAMETERS OF THE ORGANIC GLASS BY MEANS OF THE CHOPPER METHOD. Graffstein, A.; Ogrzewalski, Z.; Rzeszot, T.; Stanolow, A.; Warda, E. (Institute of Nuclear Research, Warsaw (Poland)). Feb. 1966. 10p. Dep.

The neutron diffusion parameters of the organic glass were measured by means of the pulsed method using the chopper as a pulsed neutron source. The experimental dependence of the decay constant of the thermal neutron flux as a function of buckling of examined sample was fitted to a power series in B^2 by the method of weighted least squares. Two fits were tried using series which terminated with the B^4 and B^6 terms. Calculations were performed for constant extrapolation length d = 0.34 cm and buckling dependent extrapolation length $d = d(B^2)$. (auth)

28235 (NAA-SR–11821) SPACE-TIME FLUX SYNTHESIS METHODS FOR THE APPROXIMATE SOLUTION OF TIME-DEPENDENT BOLTZMANN NEUTRON TRANSPORT EQUATION. Luco, V. (Atomics International, Canoga Park, Calif.). May 25, 1966. Contract AT(11-1)-Gen-8. 37p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

Space-time flux synthesis methods for the approximate solution of the time-dependent Boltzmann neutron transport equation are formulated. The variational and the Galerkin technique are used. The space-dependent part of the solution is obtained with the DTF-11 program—an Sn-type solution of the transport equation. Temperature feedback effects are considered in the formulation. The formulation presented here is adapted to the description of rapid transients following a large reactivity input, but the method can be easily modified to cover other reactor problems where a space-time flux description is necessary. It should be useful whenever the situation requires the transport approximation for the description of the neutron flux. (auth)

28236 (NP–16039) AN ASSOCIATED PARTICLE METHOD FOR MEASUREMENTS ON INELASTIC SCATTERING OF D-D NEUTRONS [Thesis]. Put, Louis Wichert (Amsterdam Univ. (Netherlands)). [1963]. 102p. Dep. mn.

A method for the background reduction in experiments on inelastic scattering of D-D neutrons is described. Attention is paid especially to the measurement of angular distribution of the γ-rays from the decay of states excited by inelastic scattering. Theoretical expressions for the γ-ray angular distribution, found from the statistical model for nuclear reactions, are given. In these expressions the spin and parity of the excited state are parameters; these parameters may be found from a comparison of experimental and theoretical angular distributions. Several methods are possible for γ-ray angular distribution measurements. These methods are discussed and compared. The purpose of this method is the reduction of the background occurring in the experiments. It is based on the fact that the directions of ^{3}He-particles and neutrons produced in the $D(d,n)^3He$ reaction are correlated; so by the detection of a narrow beam of ^{3}He-particles a beam of coincident neutrons is selected. The γ-rays from a scatterer placed in this neutron beam are also coincident with the detected ^{3}He-particles. So the spectra of the γ-rays from inelastic scattering of neutrons, coincident with the ^{3}He-particles, can be measured. Furthermore the number of detected ^{3}He-particles is a measure for the number of neutrons incident on the scatterer. The difficulty in such experiments is the discrimination between ^{3}He-particles and scattered deuterons from the target. In the associated particle method the ^{3}He-particles and deuterons are separated using an electrostatic deflection system and a surface barrier detector. The profiles of the coincident neutron beam were measured; a discussion is also given. To check this application of the associated particle method the angular distribution of γ-rays from inelastic neutron scattering by Fe was measured. Iron was taken because the spins and parities of the states which can be excited are known and already much information on inelastic scattering by Fe is available. The experimental procedure is described. The resulting angular distributions were compared with theoretical predictions made for a number of spin-parity combinations. These results are in good agreement with the known spins and parities of the states in ^{54}Fe and ^{56}Fe and exclude the other considered combinations. Possibilities for improvements of the associated particle method are also described. It is concluded that using this method for the background reduction, n'-γ angular correlation experiments will also be possible. (auth)

28237 (TID–22844, pp 1-35) NEUTRON THERMALIZATION. (Rensselaer Polytechnic Inst., Troy, N. Y. Dept. of Nuclear Engineering and Science).

A technique for the measurement of integral resonance parameters by the pulsed-neutron technique was discussed in the last progress report. A feasibility study was made during this period of a similar method for measuring resonance absorption in static experiments. Brief summaries are given for progress in each of the following areas of research: spatially dependent spectra in a multiplying media; modification of the three meter flight path; steady state neutron spectra measurements in borated water; fast kinetics; time dependent spectra in small Be assemblies; and calculation of time dependent spectra in D_2O. (M.O.W.)

28238 INTEGRAL METHOD OF MEASUREMENT OF β_{eff}/l VALUE. Mogil'ner, A. I.; Krivelev, G. P. At. Energ. (USSR), 20: 157-9(Feb. 1966). (In Russian).

An algorithm for evaluating the quantity $\alpha = (1 - k_{eff})(1-\beta_{eff})/l$ is described which is based on the integral method and on measurements of the dispersion fluctuations of the ionization currents of the chambers, which pass through a broad-band filter with variable-band passage. Here k_{eff} is the effective neutron multiplication factor, β_{eff} is the effective fraction of delayed neutrons, and l is the lifetime of prompt neutrons. The results of a calculation of α using this algorithm, including a description of the integrating system used, are briefly summarized. (G.O.Y.)

28239 APPROXIMATE SIMILARITY OF NEUTRON FIELDS, FORMED BY NEUTRON SOURCES WITH DIFFERENT SPECTRA. Kozhevnikov, D. A. At. Energ. (USSR), 20: 159-61(Feb. 1966). (In Russian).

The spatial distribution functions of neutrons from Po–Be and Ra–Be sources and from ^{235}U fission are compared, and it is found that polyenergetic neutrons from sources with different spectra have approximately similar fields. (G.O.Y.)

28240 TEMPERATURE DEPENDENCE OF NEUTRON DIFFUSION PARAMETERS IN WATER AND ICE. Antonov, A. V.; Granatkin, B. V.; Merkul'ev, Yu. A. At. Energ. (USSR), 20: 164-5(Feb. 1966). (In Russian).

The thermal-neutron transport cross sections for water and ice were studied. Measurements were made at temperatures ranging from −220 to +286°C; the results agreed with those of previous experiments. (G.O.Y.)

28241 LAW OF CORRESPONDING STATES AND COLD NEUTRON SCATTERING BY LIQUIDS. Sears, V. F. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys., 44: 867-75(Apr. 1966). (AECL–2404).

Although the law of corresponding states can be used in the practical analysis of cold neutron scattering data from liquids only if quantum effects are negligible, it is of interest, nevertheless, to have a quantum mechanical derivation of this law, because it is only then that one can discuss, in a completely consistent way, the conditions under which quantum effects are negligible. Such a derivation is given. Also an extension of the law of corresponding states to the velocity spectrum of an atom in a simple liquid is presented, and the manner in which this can be used to check the consistency and extend the range of applicability of theoretical models of the velocity spectrum is indicated. (auth)

28242 THE INITIAL-VALUE PROBLEM FOR A SLAB. I. ANISOTROPIC SCATTERING. Mika, Janusz (Inst. of Nuclear Research, Swierk, Poland). J. Math. Phys., 7: 833-8(May 1966).

The spectral properties of the Boltzmann operator describing the transport of monoenergetic neutrons with anisotropic scattering in a slab are considered. The Hille-Yosida theorem is applied to obtain the semi-group of operators solving the initial-value problem. (auth)

28243 THE INITIAL-VALUE PROBLEM FOR A SLAB. II. NONUNIFORM SLAB. Mika, Janusz (Inst. of Nuclear Research, Swierk, Poland). J. Math. Phys., 7: 839-43(May 1966).

The time-dependent neutron transport in a plane slab of material with variable nuclear properties is treated. The one-velocity theory and the isotropic scattering are assumed. The spectral properties of the corresponding Boltzmann operator are found, and the initial-value problem is solved. (auth)

28244 ANGULAR DISTRIBUTION IN THICK TARGETS OF A SOURCE OF $D(d,n)^3He$ NEUTRONS FOR DEUTERONS OF 100 kev. Naggiar, V.; Lafaye, L.; Breonce, P. (Bureau International des Poids et Mesures, Sevres, France). Nucl. Instrum. Methods, 41: 77-83(Apr. 1966). (In French).

The spectrum of the charged particles from the two reactions $D(d,n)^3He$ and $D(d,p)^3H$ is detected by a silicon junction set at 90° from the deuteron beam. The angular distribution of $D(d,n)^3He$ neutrons emerging from a thick target, at 100 kev deuteron energy, is obtained by detection of neutrons with a hydrogenous scintillator. The efficiency of the detector for neutrons associated with the detected ^3He particles is measured by the ratio of ^3He-neutron coincidences to ^3He counting. The efficiency for neutrons emitted in all directions other than the direction of coincidence is calculated. The differential cross section for neutron emission is given by $d\sigma(\Phi)/d\omega = \{d\sigma(1/2\pi)/d\omega\}\ (1 + A\cos^2\Phi)$, where the anisotropy factor A = 0.67 for 80 kev deuteron energy. (auth)

28245 CLASSICAL APPROXIMATION FOR TRANSMISSION DEPOLARIZATION OF A NEUTRON BEAM. Nyborg, P.; Lu, Pao; Good, R. H. Jr. (Ames Lab., Ames, Iowa). Nucl. Phys., 82: 657-61(1966).

An estimate is given using the classical approximation, of the change of polarization of a neutron due to passage through a Coulomb field and the related depolarization of a neutron beam in passing through a thick target. The approximation is expected to apply to the component of the beam that passes directly through the target without scattering, at energies such that the neutron wavelength is smaller than the atomic radius. Except when the initial polarization is parallel or antiparallel to the velocity, the depolarization is anisotropic, being larger in the direction perpendicular to the plane of the initial polarization and the velocity. For a lead target of thickness t the depolarization normal to the incident polarization is about 2 (t/cm)½% and parallel to it is about 0.02 (t/cm)%. (auth)

28246 STABILIZED MARCH TECHNIQUE APPLIED TO THE DIFFUSION EQUATION. Edwards, D. R.; Hansen, K. F. Nucl. Sci. Eng., 25: 58-65(1966).

The multigroup diffusion equations are solved by treating them as an initial value problem. The inherent error growth is controlled by repeated conditioning transformations; the error bounds on the final solution are set by the frequency of conditioning. The stabilized march technique (SMT) is comparable in speed to AIM-5 for problems involving downscatter only. The SMT is shown to be relatively insensitive to the type of scatter matrix involved and, hence, presents an advantage for problems with full scatter matrices. The technique is readily adaptable to flux synthesis, and an example is given for expanding the thermal flux in Laguerre polynomials. The SMT performs equally well in calculating higher order eigenvalues and eigenfunctions. (auth)

28247 INTERMEDIATE RESONANCE ABSORPTION IN HETEROGENEOUS MEDIA. Sehgal, Bal Raj; Goldstein, Rubin. Nucl. Sci. Eng., 25: 174-82(1966). (BNL–9516).

Resonance absorption in heterogeneous media with intermediate-mass moderators is investigated under the assumption that flux is spatially flat in each region. Intermediate resonance parameters are introduced for scattering by all species present in the system and an intermediate resonance approximation is developed for calculating them. An improved rational representation for the lump escape probability is used and the calculation of the Dancoff factor is modified to account for the intermediate nature of the scattering-removal process by the outside moderator. The resonance integrals from the intermediate-resonance approximation are compared with those from Monte Carlo and ZUT computer code calculations for the 6.7-ev resonance of ^{238}U. The intermediate-resonance approximation results are found to be in good agreement with the Monte Carlo results. The ZUT results have large errors for heavy moderators, especially in undermoderated systems. Equivalence among heterogeneous systems and between heterogeneous and homogeneous systems is discussed. In the former case, an equivalence through the intermediate parameters is established. (auth)

28248 ROOTS OF AN EQUATION IN SLOWING DOWN THEORY. Wilkins, Coleridge A. (Wollongong Univ. Coll., Australia). Nucl. Sci. Eng., 25: 199-201(1966).

The roots of the equation for the collision density per unit lethargy are investigated for a system containing hydrogen and one other species. (L.B.S.)

28249 THEORY OF RESONANCE ABSORPTION IN HETEROGENEOUS MEDIA. Henssen, Hermann (INTER-

ATOM, Cologne). Nukleonik, 8: 193-203(May 1966). (In German).

A method for calculating resonance integrals is described, which considers also "non-NR-collisions" in the moderator region. For this purpose a new concept was introduced, namely the target-energy distribution $W(E,E')dE'$ of the slowing-down density $q(E)$. The term $W(E,E')dE'$ is defined as the probability that neutrons which slow down past the energy E, leave the collision with an energy between E' and $(E' + dE')$, where $\alpha E \leq E' \leq E$. According to this definition, for $E' = E$, $q(E) \cdot W(E,E)dE$ equals the source of neutrons with energies between E and $(E - dE)$. For mathematical convenience the variable E' has been transformed to $x = (E' - \alpha E)/E \cdot (1 - \alpha)$, ranging between zero and one. With this concept the slowing-down problem can be rigorously described by a set of ordinary and partial differential for $q(E)$ and $W(E,x)$, the space integrals being neglected. Spatial variations are treated regionwise by using collision probabilities P_{ij} as functions of the macroscopic cross section in the fuel region, Σ_0. It seems sufficient to know P_{ij} only for a few values of Σ_0, and to determine other values by quadratic interpolation. A numerical procedure which was programmed for a digital computer is briefly described. This procedure allows also the calculation of overlapping resonances. Analytical and numerical solutions for a few special cases are discussed. (auth)

28250 WAVE CONCEPT OF NEUTRON TRANSPORT. Mueller, Karl-Heinz (CCR-EURATOM, Ispra, Italy). Nukleonik, 8: 218-25(May 1966).

The space and time distribution of the neutron density can be interpreted as a wave field and the multiple collision method as an application of Huygens' principle. The components of the total neutron flux in a multi-energy group model satisfies a set of hyperbolic differential equations and therefore leads necessarily to a result which exhibits a wave structure and other features of the solutions of hyperbolic systems. Due to this fact it becomes possible to extend the domain of validity of the P_1 equations by the introduction of a source correction and a set of modified coefficients. (auth)

28251 ADDENDUM TO THE PAPER "ON A CALCULATION METHOD OF RESONANCE ABSORPTION IN INFINITE HOMOGENEOUS MIXTURES." Vertes, Peter (Central Research Inst. for Physics, Budapest). Nukleonik, 8: 228(May 1966).

A correct form of asymptotic collision density for resonance scattering is derived and applied to the calculation of resonance escape probability. (L.B.S.)

28252 SIMPLE INTERPRETATION OF THE QUASI-ELASTIC SCATTERING OF SLOW NEUTRONS IN WATER. Pelah, I.; Imry, Y. (Israel Atomic Energy Commission, Rehovoth). Phys. Lett., 21: 248-50(May 15, 1966).

An aggregate picture is assumed for the structure of liquid water. The translational motions of the aggregates as units cause the quasielastic scattering of slow neutrons. This may also explain the low energy discrete modes, if these exist. (auth)

28253 MASS TENSOR APPROXIMATION OF SLOW NEUTRON SCATTERING. Kosaly, G.; Solt, G. (Central Research Inst. for Physics, Budapest). Physica, 32: 16-26(Jan. 1966).

A systematic analytical and numerical investigation of the different approximation methods of slow neutron scattering is given. The mass-tensor results are compared with the exact theory. The large recoil character of the mass-tensor approximation is shown. It is found that the Krieger-Nelkin procedure does not reproduce the mass-tensor results even if the momentum transfer goes to zero. A modification of the Krieger-Nelkin procedure is suggested. The results are sufficient to account for some recent numerical and experimental results. (auth)

28254 TOTAL NEUTRON CROSS SECTION OF SOME POLYPHENYLS IN SOLID AND LIQUID PHASE. Antonini, B.; Paoletti, A.; Gambetta, V. (CNEN, Rome). Physica, 32: 119-26(Jan. 1966).

Total neutron cross sections of benzene, diphenyl and diphenyl ether were measured by time-of-flight technique both in solid and in liquid phase, for neutrons between 0.1 and 0.0007 ev. The results are discussed in terms of internal degrees of freedom of the polyphenyl molecules and compared with the most recent theories of Boffi and Ardente. (auth)

28255 SCATTERING OF LONG-WAVE NEUTRONS FOR THE INVESTIGATION OF WIDE-RANGE DENSITY FLUCTUATIONS. Springer, T.; Schmatz, W. (Kernforschungsanlage, Julich, Ger. Physik Department, Munich). pp 73-8 of Physikertagung 1965 Frankfurt (M)-Hoechst, Okt. 4-9. Vorabdrucke von Kurzfassungen der Fachberichte. Stuttgart, B. G. Teubner Verlagsgesellschaft mbH, 1965. (In German).

For lead abstract see CONF-651030-(Vol.1) in report number index.

A review is given on the applications of long-wave neutrons for the study of density oscillations and their advantages with respect to x-ray small-angle scattering are explained. The various operative methods which were developed and constructed at the FRM and FRJ-2 research reactors are described together with some results. (tr-auth)

28256 REPORT ON EXPERIMENTS WITH COLD NEUTRONS MADE AT SACLAY. Cribier, D. (Centre d'Etudes Nucleaires, Saclay, France). pp 208-12 of Physikertagung 1965 Frankfurt (M)-Hoechst, Okt. 4-9. Vorabdrucke von Kurzfassungen der Fachberichte. Stuttgart, B. G. Teubner Verlagsgesellschaft mbH, 1965.

For lead abstract see CONF-651030-(Vol.1) in report number index.

A short review is given of neutron diffraction by vortex lines in superconductors. Experiments on critical scattering by magnetic materials are summarized. (tr-auth)

28257 A FAST CHOPPER WITH ADJUSTABLE SLIT FOR STUDYING RESONANCE NEUTRONS. PART I. THEORETICAL STUDY. Dobrescu, S. (Inst. of Atomic Physics, Bucharest). Studii Cercet. Fiz., 17: 1117-32 (1965). (In Rumanian).

In order to carry out time-of-flight studies in the resonance neutron range with a research reactor a fast chopper was designed for one of the horizontal beamholes to operate in the energy range from 0.05 to 10,000 ev. The system chosen may be adjusted according to two parameters: speed of rotation and width of the slit and thus may be used within wide ranges of luminosity and resolution. The 1.25-mm slits could be machined in a single operation. Graphs are presented for determining the best operational conditions. It is expected to use the device for studying elastic and inelastic capture and scattering studies in the thermal and epithermal range, resonance integral investigations and the testing of structural materials. Choppers present special advantages over pulsed neutron sources for the study of separated isotopes because they require only small samples. (TTT)

28258 NOTE ON THE METHOD OF CALCULATING THE NEUTRON SCATTERING LAW OF ORGANIC MODERATORS. Sekiya, Tamotsu; Sakamoto, Kaoru; Yamagishi, Tomejiro. Technol. Rep. Osaka Univ., No. 16, 277-80(Oct. 1965).

A method to improve the scattering law of polyphenyls to fit to their experimental data is proposed. Two possibilities to take into account effects of molecular vibration and rotation are shown. It is especially emphasized that the effect of inner rotation cannot be neglected. (auth)

28259 SOLUTION OF THE BOLTZMANN EQUATION FOR MONOENERGETIC NEUTRONS BY EXPANSION IN JACOBI POLYNOMIALS. Nonnenmacher, T. Karlsruhe, Ger., Technische Hochschule, 1965. 77p. $2.00 Gmelin, AED-Diss. 65-255.

Neutron transport in a source free medium with plane geometry and isotropic scattering is studied. Convergence regions for solutions by expansion in Jacobi polynomials are given. (Gmelin Inst.)

28260 NEUTRON SOURCE. Amiel, Saadia; Nir, Aharon (to Yeda Research and Development Co., Ltd.). Canadian Patent 730,778. Mar. 22, 1966. Priority date June 6, 1961, Israel.

The ability to start and stop the flow of neutrons at will is claimed as the novel feature of this source. A solid alpha emitter such as ^{228}Th or ^{210}Po is housed in a small glass bulb with inlet and outlet valves. The target material is a liquid or gas containing ^{18}O. To stop the neutron emission the fluid target material is withdrawn from the bulb. (AECL)

Nuclear Properties and Reactions

Refer also to abstracts 26802, 27290, 27306, 27309, 27315, 27674, 27952, 28165, 28236, 28244, 28247, and 28678.

28261 (AD–631954) TABLES OF COEFFICIENTS FOR ANGULAR CORRELATION OF RADIATIVE TRANSITIONS FROM ALIGNED NUCLEI. Watson, D. D.; Harris, Gale I. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). Feb. 1966. 175p. (ARL–66-0030). CFSTI $5.00 cy, $1.00 mn.

Included is a list of basic formulas and tabulations of numerical coefficients which are useful for the analysis of data on intensity-direction correlations of successive radiative transitions from aligned nuclei. The formulas are extracted from an earlier published development of the angular correlation formalism. This development is based upon a factored version of the equations which is used to extend the application from the usual two-step cascade to general multiple-step cascades. The resulting flexibility and greater efficiency of the formalism is utilized to provide an extensive tabulation of coefficients for a variety of specific applications. Coefficients are provided for analysis in terms of either the population parameters or the statistical tensors of the aligned state. The coefficients can be used for the analysis of angular distributions, triple correlations, and triple correlations involving one or more intermediate unobserved radiations. In contrast with previous tabulations of coefficients for angular-correlation analysis, the range of the present tables was extended to include multipolarities through octupole. The overall length of the tables, however, remains about the same as previous tables because of the greater efficiency of the factored formalism. The range of spins covered by the tables are $J \leq 1\frac{1}{2}$ for the initial aligned state and $J \leq 2\frac{1}{2}$ for the final state of a cascade. (auth)

28262 (AD–632242) CALCULATIONS OF THE ENERGY AND MASS YIELDS FROM THE THERMAL-NEUTRON FISSION OF ^{235}U. Ferguson, J. M.; Read, P. A. (Naval Radiological Defense Lab., San Francisco, Calif.). Mar. 15, 1966. 46p. (USNRDL-TR–992). CFSTI $2.00 cy, $0.50 mn.

Improvements in a semi-empirical correlation of the energy and mass yield data for ^{236}U fission are presented. The available mass, energy, and neutron emission data are correlated with each other within the accuracy of the input data. A simple model of the ^{236}U fragments at scission is presented. This model, together with some experimental data, is used to predict the surface tension parameters of the fragments and kinetic energies of the fragment pairs. The calculated kinetic energies agree reasonably well with experiment. The surface tension parameters of the fragments show strong shell effects, as indicated in other studies. The shapes of the fragments at scission are estimated from the model. (auth)

28263 (AECD/EP–10) SCATTERING OF 21- TO 24-Mev ALPHA PARTICLES BY Ne. Sen Gupta, H. M.; Khan, A. H. (Atomic Energy Centre, Dacca (Pakistan)). Mar. 1966. 9p. Dep. mn.

Nuclear emulsion techniques were used to study the scattering of α-particles by Ne. Elastic angular distributions were obtained at 20.9, 22.6, and 24.0 Mev over the cm angles 17° to 170° and at 21.4, 21.8, 22.9, and 23.3 Mev over 136° to 170° and inelastic scattering leading to the 1st excited state in ^{20}Ne at 20.9, 22.6, and 24.0 Mev over 17° to 165° cms. Both elastic and inelastic angular distributions show strong diffraction oscillations. (auth)

28264 (AECD-TP–7) OPTICAL MODEL CALCULATIONS OF ELASTIC SCATTERING IN LIGHT NUCLEI. Rahman, M.; Khan, A. H.; Sen Gupta, H. M. (Atomic Energy Centre, Dacca (Pakistan)). Mar. 1966. 12p. Dep. mn.

Diffuse surface optical model analyses were carried out to fit experimental elastic angular distributions in $p-{}^4He$, $d-{}^4He$ and $^3He-{}^4He$ systems and best fit parameters were obtained. (auth)

28265 (AI–66-85) TUNGSTEN RESONANCE INTEGRALS AND DOPPLER COEFFICIENTS. Quarterly Progress Report No. 3, January–March 1966. Carpenter, S. G.; Levitt, L. B.; Otter, J. M.; Paschall, R. K.; Royden, H. N. (Atomics International, Canoga Park, Calif.). May 13, 1966. Contract NAS3-7982. 17p. (NASA-CR–54954).

The final 15-group calculation of parameters of the 10.6-in. SGR-CA lattice was completed. Multigroup effective cross sections were calculated for the actual isotopic compositions of the ^{182}W and ^{186}W samples. From these (and previous) cross sections and the multigroup real and adjoint fluxes, expected reactivities were computed for samples of natural tungsten, ^{182}W, ^{186}W, and gold. Doppler coefficients were calculated for the three tungsten samples. Agreement of these quantities with experiment is as good as could be expected for absolute reactivity calculations; however, measured reactivity ratios among the three samples are significantly different from calculated ratios. An existing Monte Carlo resonance-escape code was modified so that only those neutron histories resulting in passage through the sample are followed. This relatively minor modification has greatly increased the efficiency of the code. Activation measurements of the ^{186}W resonance integral were completed at two temperatures, 293 and 473°K. Reactivity worths and Doppler coefficients of samples enriched in ^{182}W and in ^{186}W were measured in the cadmium sleeve at the center of SGR-CA. Doppler measurements were made at several temperatures from room temperature to above 1000°K. Reactivities of gold samples with widely varying surface-to-mass ratio were measured to allow absolute calibration of the reactivity measurements. (auth)

28266 (AWRE-O–27/66) DICE MK. V: THE PREPARATION OF NUCLEAR DATA INTO A FORM SUITABLE FOR MONTE CARLO CALCULATIONS USING AN ELECTRONIC COMPUTER. Parker, J. B. (ed.) (Atomic Weapons Research Establishment, Aldermaston (England)). May 1966. 104p. Dep. BIS $2.80. HMSO 14s.

The nuclear data used in multigroup neutronics calculations on a high speed digital computer at AWRE are characterized by their vastness and their complexity. The task of synthesizing the data (for a given nuclide), embracing as it does the intercomparison of different experiments, weighting them in accordance with their general reliability and interconsistency, is a laborious and highly specialized procedure. The product of this synthesis is the UKAEA Nuclear Data Library, in the form of punched cards, which follows a definite format. Included is a description of the way in which the contents of the UKAEA Nuclear Data Library are converted for use in calculations employing the Monte Carlo method. (M.O.W.)

28267 (BNL–10135) NUCLEAR STRUCTURE MEASUREMENTS WITH THE BROOKHAVEN COSMOTRON. Friedes, J. L.; Palevsky, H.; Sutter, R. J.; Bennett, G. W.; Stearns, R. L.; Corley, D. M.; Wall, N. S.; Phillips, G. C.; Simpson, W. D. (Brookhaven National Lab., Upton, N. Y.). Feb. 1966. Contract AT(30-2)-Gen-16. 13p. (CONF-660209–4). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From Conference on Intermediate Energy Physics, Williamsburg, Va.

An investigation was made on the Brookhaven Cosmotron to determine whether the energy resolution and energy stability of the machine are adequate for nuclear structure

measurements. An experimental setup employing the Cosmotron is described. Preliminary results from this setup are described. (M.O.W.)

28268 (FEI–30) SPEKTRY NEUPRUGO RASSEYANNYKH NEITRONOV S NACHAL'NOI ENERGIEI 14.1 Mev I PLOTNOST' YADERNYKH UROVNEI. (Spectra of Inelastic Scattering of Neutrons with Initial Energy of 14.1 Mev and Density of Nuclear Levels). Sal'nikov, O. A.; Fetisov, N. I.; Lovchikova, G. N.; Kotel'nikova, G. V.; Anufrienko, V. B.; Devkin, B. V. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). 1965. 18p. Dep. mn.

The spectra of secondary neutrons formed in the interaction of 14.1-Mev neutrons with the nuclei of Be, Na, Mg, S, K, Ca, In, Sb, I, Cs, Ce, Ta and Hg were measured, establishing the relationship between the nuclear temperature, the density parameter of the nuclear surfaces and the mass number A. The mechanism of the (n,n') reactions and the spectra of neutrons generated by the (n,2n) reaction were also clarified. Annular scatterers were used in the experiments, holding Na, K, I, Cs and Hg in suitable containers. The results presented reflected a consideration of the correction for the dead time of the spectrometer, activation of the samples, effect of the scatterer, background, and the photomultiplier noise. On the basis of the experimentally measured scattered neutron spectra N(E), graphs of In[N(E)/E] and In[N(E)/$E^{3/2}$] were plotted. It was found possible to obtain inelastically scattered neutron spectra of medium and heavy nuclei through the nuclear temperature. On the basis of the linear correlation between IN/E and E it was found that if the initial neutron energy is 14.1 Mev, at least 80% of the scattering results in the formation of new nuclei. Change of the nuclear temperature with the excitation energy agrees with the Fermi gas model. The level density increases with the mass number, except for nuclei closed to filled shells. (TTT)

28269 (BNL–10196) ANALOGUE STATES OBSERVED VIA DELAYED PROTON EMISSION. McPherson, R. (Brookhaven National Lab., Upton, N. Y.). [1966]. Contract AT(30-2)-Gen-16. 12p. (CONF-660306–7). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From American Physical Society, Conference on Isobaric Spin, Tallahassee.

A discussion is presented on the observation of proton emission following super-allowed beta decay which allows easy identification on the analog states of the beta-decay daughters. A level diagram illustrating superallowed beta decay of the most neutron deficient member of a T = $^3/_2$ multiplet followed by T forbidden proton emission is presented. The proton spectra following ^{25}Si beta decay is discussed. (M.O.W.)

28270 (FEI–28) UGLOVYE RASPREDELENIYA I CHISLO KASKADNYKH NUKLONOV, ISPUSKAEMYKH YADRAMI PRI VZAIMODEISTVII S PROTONAMI S ENERGIEI 660-Mev. (Angular Distribution and Number of Cascade Nucleons Emitted by Nuclei During Interaction with 660-Mev Protons). Kon'shin, V. A.; Matusevich, E. S.; Regushevskii, V. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). 1965. 12p. Dep. mn.

The theory of nuclear reactions at energies of several hundreds of Mev is based on Heisenberg's concept of the interaction of fast particles with nuclei as a series of successive collisions with the nucleons in the nucleus and release of the excitation of the residual nucleus by the evaporation of the nucleons, corresponding to the "fast" and "slow" stages of the interaction, respectively. The angular distribution and the number of such cascade nucleons emitted by C, Al, Ni, Cu, Cd, Pb, and U target nuclei were determined for proton beams, the energies of which determined on the basis of the ^{24}Na activity from the ^{27}Al(p,3pn) ^{24}Na reaction and from ^{209}Bi fission. The angular distribution of the energy of the cascade nucleons was calculated from the energy distribution data of secondary nucleons. It was found that the lighter the nucleus, the more marked is the anisotropy in the angular distribution of secondary nucleons because with increasing mass number of the target nucleus the incident proton is subjected to a larger number of collisions inside the nucleus. The experimental data of the number of cascade nucleons agrees with theoretical predictions for nuclei lighter than Cu; a 1.5-fold divergence was noted for the heavier nuclei. (TTT)

28271 (JAERI–1103) ^{148}Pm AS A PRIMARY PRODUCT OF THERMAL NEUTRON FISSION OF ^{233}U AND ^{235}U. Umezawa, Hirokazu (Japan Atomic Energy Research Inst., Tokyo). Dec. 1965. 10p. Dep. mn.

It was intended to determine the independent fission yields of ^{148m}Pm and ^{148g}Pm in the thermal neutron fission of ^{235}U and ^{233}U. The contribution of the ^{147}Pm(n,γ)^{148}Pm reaction, which also occurs as the secondary reaction, was experimentally corrected by means of the simultaneous irradiation of a neodymium target and a uranium target. The fission yields of ^{148}Pm could not be determined, but only their upper limits were estimated. These values are too small by a factor of 5 for ^{235}U and 50 for ^{233}U, compared with the values expected from the present systematics of nuclear charge distribution in fission. (auth)

28272 (JAERI–1104) FAST NEUTRON SPECTRUM AND GROUP CONSTANT CODE 7044 UGMG. Katsuragi, Satoru; Moriguchi, Kinichi; Kuge, Yasushi (Japan Atomic Energy Research Inst., Tokyo). Aug. 1965. 28p. (In Japanese). Dep. mn.

The fast neutron spectrum and cross section calculating code for the IBM 7044 digital computer was developed, which is a modified version of the fast neutron spectrum code, MUFT. 54-group microscopic cross sections for up to 65 nuclides can be stored in a tape. Fast neutron spectra are calculated by P-1 or B-1 approximation. Slowing down of two light nuclides can be treated by either Selengut-Goertzel or Greuling-Goertzel approximation, and the rest (heavy nuclides) by either age or consistent age approximation. The heterogeneity effect on the resonance escape probability can be taken into account. The Doppler effect on the resonance absorption can be incorporated in the code. A neutron balance is maintained in the calculation, including inelastic scattering. Few-group constants and the cross sections of specified nuclides are listed as the output data. A separate input program is available for modification of the multigroup cross section tape. The execution time per case is about two minutes. (auth)

28273 (JINR–P-2625) AL'FA-RASPAD S VYSOKOVOZBUZHDENNYKH SOSTOYANII IZOTOPOV SAMARIYA. (Alpha Decay From Highly Excited States of Sm Isotopes). Kvitek, I.; Popov, Yu. P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1966. 8p. Dep. mn.

The α-transition probabilities from strongly excited states of ^{148}Sm and ^{150}Sm with different spins were investigated. The samarium nuclei were excited by resonance nuclei. The lifetimes (with respect to the alpha-decay) were obtained for excited states with spins 4^- and 3^-. Calculations, made by the statistical theory, of transition probabilities $4^- \rightarrow 2^-$ in ^{150}Sm are in good agreement with experiment. A comparison of the lifetimes for 9 states of ^{148}Sm shows that they fluctuate within $(0.23-3.9)\cdot 10^{-9}$ sec. The lifetimes for the 3^- and 4^- levels are different by an order of magnitude. (auth)

28274 (JINR–P-2647) NOVYE IZOTOPY ^{141}Sm I ^{140}Sm. (New Isotopes ^{141}Sm and ^{140}Sm). Kherrmann, E.; Pfrepper, G.; Khristov, D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1966. 12p. Dep. mn.

New isotopes of ^{141}Sm and ^{140}Sm were found in the spallation products of erbium bombarded with 660-Mev protons. Their half lifes are (22.5 ± 1.4) min and (13.7 ± 0.8) min, respectively. The existence of these isotopes was proved by means of repeated chemical isolation of ^{141}Pm, ^{141}Nd and ^{140}Nd from samarium. The chemical separation was performed by the extraction-chromatographic method with HDEHP fixed on silicagel, as well as by the Szilard-Chalmers reaction in phthalocyanine complex of samarium. (auth)

28275 (JINR-P-2651) SPEKTR gamma-LUCHEI $^{172}Hf + ^{172}Lu$. (gamma-Ray Spectrum of $^{172}Hf + ^{172}Lu$). Vrzal, Ya.; Dzhelepov, B. S.; Liptak, Ya.; Urbanets, Ya.; Shestopalova, S. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1966. 12p. Dep. mn.

Measurements were made of γ-rays from the radioactive decay of the $^{172}Hf + ^{172}Lu$ mixture by means of a coaxial Ge(Li) detector with a sensitive volume of about 5 cm^3. Relative intensities of γ-transitions of ^{172}Lu were determined for the energy range 50 to 2100 kev on the basis of these measurements. (auth)

28276 (JINR-P-2664) DIFRAKTSIONNYI EFFEKT V UGLOVOM RASPREDELENII PRODUKTOV REAKTSII PEREDACHI. (Diffraction Effect in the Angular Distribution of Transfer Reaction Products). Gareev, F. A.; Grabovskii, Ya.; Kalinkin, B. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 10p. Dep. mn.

The diffraction effect in the angular distribution of the transfer reaction products was treated. Its relation to the parameters of the problem of collision between nuclei is established. It is qualitatively explained why there exists an asymmetry in the half widths of the energy spectrum of the stripping and pickup reaction products. (auth)

28277 (JUL-337-RG) UEBER EINIGE METHODEN ZUR EXPERIMENTELLEN BESTIMMUNG DES SCHNELLSPALTFAKTORS VON BERYLLIUMMETALL UND BERYLLIUMOXYD. (Some Methods for the Experimental Determination of the Fast Fission Factor of Beryllium Metal and Beryllium Oxide). Kirch, Norbert; Heckmann, Paul H.; Hecker, Rudolf (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung). Nov. 1965. 29p. Dep. mn.

The methods devised for the experimental determination of the fast fission factor for beryllium and beryllium oxide were described. The methods described are: manganese sulfate activation using reactor thermal neutrons, measurement of the fast fission factor using a cadmium charged liquid scintillator tank, the measurement of the fast fission factor using a californium source, and measurement on pulsed neutron generators. The technique planned for each method is described in some detail. (J.S.R.)

28278 (JUL-354-RG) THERMISCHE WIRKUNGSQUERSCHNITTE UND RESONANZABSORPTIONSINTEGRALE VON SPALTPRODUKTEN. (Thermal Effective Cross Section and Resonance Absorption Integrals of Fission Products). Stippel, E. S. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung). Dec. 1965. 29p. Dep. mn.

The thermal effective cross sections and resonance integrals of fission products and isotopes were compiled from original studies and reports published since 1956. No evaluation of the data is made, and when several values are available for the same isotope all are given without comment. (J.S.R.)

28279 (JUL-355-RX) ABSOLUTMESSUNG DER ZERFALLSRATE EINES RADIOAKTIVEN STRAHLERS MIT KOMPLEXEM ZERFALLSSCHEMA MIT HILFE EINER 4π β-γ KOINZIDENZANLAGE. DIE ABSOLUTMESSUNG VON ^{60}Co AND ^{58}Co. (Absolute Measurement of the Decay Rate of a Radioactive Emitter with Complex Decay Scheme Using a 4π β-γ Coincident Installation. The Absolute Measurement of ^{60}Co and ^{58}Co). Dieck, L. (Kernforschungsanlage, Juelich (West Germany). Zentralinstitut fuer Reaktorexperimente). Jan. 1966. 68p. Dep. mn.

A 4π β-γ coincidence installation was constructed. This installation contains, in addition to the 4π β methane flow through counter, two electronic γ channels stabilized against amplifier oscillations so that γ-γ coincidences and 3-fold coincidences between a β decay and 2γ decays can also be measured in addition to the β-γ coincidences. This measurement installation is the first 4π β-γ coincidence apparatus to contain a 4π β counter with a prerinsed chamber in order to prevent the introduction of air along with the preparation into the counting chamber. Circuits and measurement methods were worked out with which the apparatus can rapidly be adapted from the measurement of one radioisotope to the measurement of another. In the 4π β counter it is possible through separated cathode follower and a relayed circuit to determine separately the upper and lower β counter size. Therefore a new method is obtained for the determination of the correction for self coincidences. A correction method for the absolute measurement of ^{60}Co using the 4π β-γ coincidence installation was developed. In absolute measurements of ^{58}Co with a 4π β-γ coincidence apparatus a high counting yield for the secondary electrons in the 4π β counter is obtained because of the low contribution of the positrons to the total decay. The corrections for these secondary electrons and for the pseudo coincidences were very large. With a special measurement and correction method worked out for the absolute measurement of ^{58}Co, the corrections were determined so accurately that the resulting total correction factor could be determined to ±1.5%. (tr-auth)

28280 (LYCEN-6610) ETUDE ET REALISATION D'UN DISPOSITIF EXPERIMENTAL DE MESURES DE DISTRIBUTIONS ANGULAIRES, DE SECTIONS EFFICACES ET DE POLARISATION DANS CERTAINES REACTIONS (p,p). APPLICATION A LA DIFFUSION ELASTIQUE $^{12}C(p,p)^{12}C$ ENTRE (1.95 ET 1.23 Mev) [Theses]. (Study and Development of an Experimental Apparatus for the Measurement of Angular Distributions, Effective Cross Sections, and Polarization in Some (p,p) Reactions. Application to the Elastic Scattering $^{12}C(p,p)^{12}C$ Between 1.95 and 1.23 Mev [Thesis]). Lebre, Jean-Marie (Lyon Univ. (France). Institut de Physique Nucleaire). Mar. 1966. 114p. Dep. mn.

An experimental device for the measurement of the angular distributions, effective cross sections, and polarization in (p,p) reactions was described. After a brief but theoretical review, the method used for the measurement of polarization is described. The apparatus constructed is described in detail with particular emphasis on the double scattering polarimeter with carbon analyzer and the electronic detection circuits. The experimental method used in the measurement of the polarization is described in detail. The results obtained are reported for energies above 2 Mev. The experimental results obtained with carbon for energies between 1.5 and 2 Mev at angles of 45° are in good agreement with theoretical predictions. (J.S.R.)

28281 (ORNL-P-2074) DIRECT SOLUTION OF LANE EQUATION AND THE ANALOGUE STATE RESONANCE IN (p,p) PROCESS. Tamura, Taro (Oak Ridge National Lab., Tenn.). [1965]. Contract W-7405-eng-26. 8p. (CONF-660306-6). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From American Physical Society, Conference on Isobaric Spin, Tallahassee.

In order to explain the peaks in the spectra of neutrons from (p,n) reactions, Lane introduced a new term of the form U_1 (t · T), into the usual optical model potential. If this term is considered explicitly in an optical model calculation, it gives rise to a set of coupled equations between the proton and neutron channels. Because of the coupling between the (p) and (n) channels, this resonance is reflected into the (p) channel and a narrow resonance is expected to occur in the (p,p), (p,n) and other reactions. With a reasonable set of optical model parameters, it is shown that such resonances are indeed predicted at the right energies and that the excitation functions thus derived are in good agreement with experiment. (M.O.W.)

28282 (ORNL-P-2091) MEASUREMENTS OF LOW ENERGY NEUTRON CROSS SECTIONS OF NON-FISSILE NUCLIDES AND THEIR INTERPRETATION. Harvey, J. A. (Oak Ridge National Lab., Tenn.). [1966]. Contract W-7405-eng-26. 36p. (CONF-660303-29). Dep. mn. CFSTI $2.00 cy, $0.50 mn.

From American Physical Society, Conference on Neutron Cross Section Technology, Washington, D. C.

Transmission, capture, and scattering measurements can

be made with high resolution and accuracy up to 100 ev upon any non-fissile stable nuclide if a suitable sample (~grams) is available. These measurements can be analyzed by the shape or area method to give accurate parameters for all but the very small resonances. Measurements upon small samples (~mgms) with low isotopic enrichment or which are highly radioactive can give accurate parameters up to ~10 ev and for the strong resonances up to ~100 ev. Cross section measurements and resonance analysis of several nuclides which are or have been of interest in the design of thermal and intermediate energy reactors are described. (auth)

28283 (PD-261) ELASTIC SCATTERING OF PROTONS BY NITROGEN. A Preliminary Report. Ferguson, A. J.; Clarke, R. L.; Gove, H. E.; Sample, J. T. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Project). June 1956. 41p. Dep. mn.

The elastic scattering of protons by nitrogen was studied in the energy range 1.0 to 2.9 Mev. Resonances were found at 1.065, 1.557, 1.743, 1.803, 2.344, and 2.468 Mev. Earlier opinion that P-wave phase shifts are not significant below about 2.0 Mev appears to be incorrect. The suggested assignment of $^3/_2-$ for the 1.743 Mev level is probably wrong. (auth)

28284 (RLO-1388-5) (α,^{7}Li) REACTIONS ON ^{11}B, ^{15}N, AND ^{19}F AT 42 Mev. Mizera, Paul; Gerhart, J. B.; Slee, F. (Washington Univ., Seattle). Apr. 1966. Contract AT(45-1)-1388. 11p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

The pickup of 3 nucleons from the 1p and 2s, 1d shells using 42-Mev alpha particles from the 60" cyclotron at the University of Washington is discussed. The experimental technique is briefly outlined. Angular distributions and cross sections are among the results discussed. (M.O.W.)

28285 (TID-22018) THE ISOMER SHIFT IN MERCURY. Barrett, R. C. (Columbia Univ., New York). [1964]. Contract AT(30-1)-1808. 17p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Calculations were made on the change in the mean square charge radius of ^{199}Hg when the last odd neutron is excited from the $p_{\frac{1}{2}}$ ground state to the $i_{\frac{13}{2}}$ isomeric state. The calculations were carried out by assuming a certain neutron-proton force, and using first-order perturbation theory to obtain the amplitudes of monopole excitations of the proton core. (auth)

28286 (TID-22844) LINEAR ACCELERATOR PROJECT. Progress Report for October 1965-December 1965. Gaerttner, E. R. (Rensselaer Polytechnic Inst., Troy, N. Y. Dept. of Nuclear Engineering and Science). Contract AT(30-3)-328. 82p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Separate abstracts were prepared for 4 of the 5 included sections. The remaining section briefly outlined planned research on electron radiation damage studies on semiconductors. (M.O.W.)

For abstracts of individual sections see: 28237, 27267, 28287, and 28288.

28287 (TID-22844, pp 36-53) NEUTRON CROSS SECTIONS. (Rensselaer Polytechnic Inst., Troy, N. Y. Dept. of Nuclear Engineering and Science).

Brief summaries of research progress in each of the following areas are presented: spark chamber experiments, neutron capture measurements in iron, preliminary total neutron cross section measurements of ^{240}Pu, high energy neutron inelastic scattering, lithium-drifted Ge detector, and preliminary resonance capture gamma spectra in Fe, Mn, and Tm. (M.O.W.)

28288 (TID-22844, pp 54-61) LOW ENERGY NEUTRON INELASTIC SCATTERING (LENIS). (Rensselaer Polytechnic Inst., Troy, N. Y. Dept. of Nuclear Engineering and Science).

Installation of the new low energy neutron scattering facility is almost completed. The scattering chamber shielding is assembled, the magnet system was tested and accepted, and the new fast chopper was installed. This work is briefly described. (M.O.W.)

28289 (UCRL-16768) COLLECTIVE POTENTIAL ENERGY, QUANTUM MECHANICAL FLUCTUATIONS AND TUNNELING EFFECTS IN EVEN NUCLEI. [PART] I. Kumar, Krishna (Lawrence Radiation Lab., Univ. of California, Berkeley). Mar. 1966. Contract W-7405-eng-48. 48p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

A dynamical description of collective quadrupole motion is given. Quantum mechanical fluctuations of nuclear shapes and their effects on coupling between rotations and vibrations, and between β-vibrations and γ-vibrations, are investigated. These effects indicate the need of a more complicated β-, γ-dependence of the collective potential energy than that used in the past. A potential function, which is an extension of the Myers-Swiatecki potential, is suggested. On using this extended potential, good agreement is obtained with the experimental energy levels and B(E2) values of ^{154}Sm. The general nature of the potential is utilized to gain some qualitative understanding of other nuclei. A metastable band, which represents quantum mechanical tunneling and which can decay to the ground band only through a cascade involving one of the excited bands, is predicted. (auth)

28290 HARD-CORE NUCLEON SYSTEM WITH NEUTRON EXCESS. Dabrowski, J.; Hassan, M. Y. M. (Univ. of Warsaw). Acta Phys. Pol., 29: 309-24(Mar. 1966).

The known expansion of the ground state energy of a system of hard core fermions in powers of $k_F c$ (k_F = Fermi momentum, c = hard core radius) is extended to include the case of nuclear matter with a neutron excess and the case of one kind of fermions (e.g., liquid ^{3}He) with a "spin up excess". The calculation includes terms quadratic in $k_F c$. Expressions for the nuclear symmetry energy and the spin symmetry energy are given. An approximation applied earlier by Brueckner, et al., in computing both of these quantities is discussed. (auth)

28291 GAMMA-GAMMA DIRECTIONAL CORRELATIONS IN ^{145}Sm. Goworek, T.; Skorzynski, Z.; Wawryszczuk, J. (Curie-Sklodowska Univ., Lublin). Acta Phys. Pol., 29: 407-9(Mar. 1966).

Directional correlations of gamma cascades in ^{145}Eu → ^{145}Sm decay were measured. The spin of 1435-kev level is found to be $^1/_2$, the spin of 1547-kev level is probably $^3/_2$. (auth)

28292 FINE STRUCTURE OF THE ALPHA RADIATION OF ^{235}U. Gaeta, Rafael (Junta de Energia Nuclear, Madrid). An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. A, 62: 27-32(Jan.-Feb. 1966). (In Spanish).

A study of the ^{231}Th excited levels from the alpha decay of the ^{235}U is carried out. The alpha particle spectrum was measured by means of a semiconductor counter spectrometer with an effective resolution of 18 kev. Nineteen new lines were identified. (auth)

28293 STUDIES OF THE GAMMA SPECTRA OF ^{235}U. Gaeta, Rafael; Campos, Jose; Warzanskyj, Wsewolod (Junta de Energia Nuclear, Madrid). An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. A, 62: 33-43(Jan.-Feb. 1966). (In Spanish).

The gamma spectra from the decay of the ^{235}U, both alone and in coincidence, are studied. The improved measurement conditions and a careful radiochemical separation of the decay products have permitted the identification of 8 new gamma-ray lines. As a result of this study, a new decay scheme for the ^{235}U is proposed. (auth)

28294 DOUBLE TRANSFER REACTIONS OF NUCLEONS. APPLICATION TO THE REACTIONS ^{14}N(^{3}He,p)^{16}O AND ^{27}Al(^{3}He,p)^{29}Si. Bassompierre, Gabriel (Institut de Recherches Nucleaires, Strasbourg). Ann. Phys. (Paris) (14), 1: 17-55(Jan.-Feb. 1966). (In French).

The mechanisms of direct interaction and of the compound nucleus and their incidences in the reactions induced by ^{3}He are examined. The theory of Newns on the differential cross section of a (^{3}He,p) reaction is described. A more complete formalism is then developed and the

effects of Coulomb interactions on the form of angular distribution are calculated. The experimental techniques used for proton detection are described. The experimental results obtained from the study of the mechanism of the $^{14}N(^3He,p)^{16}O$ $^{27}Al(^3He,p)^{29}Si$ reactions are reported. The results are analyzed by means of a 2-nucleon stripping formalism. (J.S.R.)

28295 METHOD FOR DETERMINING MASS DISTRIBUTION OF NUCLEAR FISSION FRAGMENTS. Karamyan, S. A. At. Energ. (USSR), 20: 151-2(Feb. 1966). (In Russian).

A set of formulas for determining the mass distribution of fission fragments in a reactor is given. The formulas cover dispersion angles of up to 180°. (G.O.Y.)

28296 INVESTIGATION OF DELAYED NEUTRONS EMITTED DURING ^{238}U FISSION BY 14.7-Mev NEUTRONS. Butsko, M. (Inst. for Nuclear Research, Hungarian Academy of Sciences, Debrecen). At. Energ. (USSR), 20: 153 (Feb. 1966). (In Russian).

The half-life periods and relative intensities of delayed neutrons emitted in neutron fission of ^{238}U at 14.7 Mev were measured. The results are in agreement with previous experimental observations. (D.C.W.)

28297 EXCITATION FUNCTIONS AND YIELDS FOR $^{181}Ta(d,2n)^{181}W$ AND $^{181}Ta(p,n)^{181}W$ REACTIONS. Krasnov, N. N.; Dmitriev, P. P. At. Energ. (USSR), 20: 154-5(Feb. 1966). (In Russian).

The excitation functions for the reaction $^{181}Ta(d,2n)^{181}W$ at 21 Mev and the reaction $^{181}Ta(p,n)^{181}W$ at 22 Mev were measured. Calculations of the excitation functions were also made. Absolute measurements of the half life of ^{181}W were performed using gamma scintillation spectrometry. The results are in agreement with previous experimental observations. (D.C.W.)

28298 PROPERTIES OF THE 254 ISOTOPE OF ELEMENT 102. Donets, E. D.; Shchegolev, V. A.; Ermakov, V. A. At. Energ. (USSR), 20: 223-30(Mar. 1966). (In Russian).

The isotope $^{254}102$ was formed in the nuclear reactions $^{242}Am(^{15}N,4n)^{254}102$ and $^{238}U(^{22}Ne,6n)^{254}102$. The identification of $^{254}102$ was made from its daughter product ^{250}Fm using chemical methods. The dependence of the cross sections of these reactions on the energy of the bombarding ions was investigated. It was shown that $^{254}102$ undergoes α decay with a period of approximately 50 sec. The results do not agree with previously published data in which a half life of 3 sec was reported. (tr-auth)

28299 DECAY CHARACTERISTICS OF THE 254 ISOTOPE OF ELEMENT 102. Zager, B. A.; Miller, M. B.; Mikheev, V. L.; Polikanov, S. M.; Sukhov, A. M.; Flerov, G. N.; Chelnokov, L. P. At. Energ. (USSR), 20: 230-2 (Mar. 1966). (In Russian).

The isotope $^{254}102$ was formed in the reaction ^{243}Am $(^{15}N,4n)^{254}102$. By recording the α decay of the primary and daughter nuclei, it was established that the period of the decay of this isotope is in the interval from 20 to 50 sec and that the energy of the α particles emitted is 8.10 ± 0.05 Mev. The results obtained do not agree with the data reported in the literature ($T_{1/2}$ = 3 sec and E_α = 8.3 Mev). (tr-auth)

28300 DELAYED NEUTRONS FROM PHOTOFISSION OF HEAVY NUCLEI. Nikotin, O. P.; Petrzhak, K. A. At. Energ. (USSR), 20: 268-70(Mar. 1966). (In Russian).

Absolute and relative time-of-flight measurements were carried out on delayed neutrons from the photofission of ^{239}Pu, ^{232}Th, ^{235}U, and ^{238}U. The results agreed with the semi-empirical classification of delayed neutron yields for these isotopes, but the absolute yields of delayed neutrons for ^{232}Th and ^{238}U differed from previously reported values. (G.O.Y.)

28301 PHOTONUCLEAR GIANT RESONANCE IN ^{20}Ne. Parker, A. W.; Whitehead, R. R.; Shute, G. G. (Univ. of Melbourne). Austral. J. Phys., 19: 147-55(Apr. 1966).

Angular distribution measurements of γ rays from the reaction $^{19}F(p,\gamma)^{20}Ne$ over the isolated prominent peak in the yield curves of γ_0 and γ_1 at 17.8 Mev (E_p = 5.2 Mev) excitation energy are reported: for γ_0, $W(\theta) \sim 1 + (0.14 \pm 0.03)P_1 - (0.69 \pm 0.04)P_2$, for γ_1, $W(\theta) \sim 1 + (0.08 \pm 0.03)P_1 + (0.27 \pm 0.03)P_2$. The difference in the sign of the P_2 coefficients shows that, irrespective of the presence of the small P_1 coefficients, the peak cannot be represented as a simple isolated 1^- resonance. (auth)

28302 CONTRIBUTION TO THE STUDY OF THE STRUCTURE OF LIGHT NUCLEI WITH CLOSED SHELLS OR SUBSHELLS USING THE PICKUP REACTION AT 155 Mev. Detraz, Claude. Cah. Phys., 19: 359-400 (Sept. 1965). (In Rumanian).

The (p,d) reactions on ^{12}C, ^{16}O, and ^{40}Ca were studied at 155 Mev at deuteron emission angles up to 35°. The experimental method used is described in detail. The transformation processes and the absolute cross sections were determined. The mechanism of the (p,d) reaction was discussed and a general interpretation is given of the energy spectra observed. The angular distributions were calculated. The results showed that at incident energies above 100 Mev the (p,d) reaction is caused by a pickup mechanism where the incident proton reacts with a neutron of the nucleus and, in the first approximation, with it alone. In the three nuclei studied the most intense peaks of the excited states are those predicted by the shell model; they correspond to holes in the external subshells of the initial nucleus. The intensity of these peaks corresponds in the first approximation to the occupation numbers of the different subshells. However to explain some of the weakly excited levels it is necessary to assume that the nuclei studied are described by a mixture of configurations. The results on the determination of the nuclear structure showed that it can be described by an independent particle model and that the pickup reaction is due to the interaction of the incident proton with a single neutron of the nucleus. (J.S.R.)

28303 THERMAL-NEUTRON FISSION YIELDS OF ^{229}Th. Harvey, J. W.; Clarke, W. B.; Thode, H. G.; Tomlinson, R. H. (McMaster Univ., Hamilton, Ont.). Can. J. Phys., 44: 1011-19(May 1966).

The relative cumulative yields for isotopes of the elements krypton, strontium, xenon, cesium, cerium, and neodymium formed in the thermal-neutron fission of ^{229}Th were determined by mass spectrometric techniques. Normalization of the relative yields by means of the isotope dilution and isobaric techniques allowed estimates to be made of the absolute cumulative yields of the heavy-mass group by forcing the sum of the yields to total 100%. (auth)

28304 PROPERTIES OF LEVELS AT 6.69 AND 6.88-6.89 Mev IN ^{28}Si. Levesque, R. J. A.; Ollerhead, R. W.; Blackmore, E. W.; Kuehner, J. A. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys., 44: 1087-97(May 1966). (AECL-2417).

Levels at 6.69, 6.88, and 6.89 Mev were observed in the $^{16}O(^{16}O,\alpha)^{28}Si$ reaction, and angular correlations were measured for the resulting gamma-ray transitions, using the geometry in which the alpha particle is detected at 0°. The level at 6.69 Mev had not been reported previously and was assigned spin and parity 0^+. The doublet of levels at 6.88–6.89 Mev was not resolved in these measurements, but angular correlations of the gamma-ray transitions were possible, using spectrum subtraction techniques. One member of the doublet, previously assigned spin 3, has a strong ground-state transition; the angular correlation for this transition confirms a 3^- assignment to this level. The other member of the doublet, which decays almost entirely to the first excited state, could not be assigned a spin on the basis of these measurements. However, taken in conjunction with other measurements, an assignment of 4^+ is favored. (auth)

28305 BETA-GAMMA ANGULAR CORRELATION IN ^{74}As. Habib, E. E.; Ogata, H.; Armstrong, W. (Univ. of Windsor, Ont.). Can. J. Phys., 44: 1157-68(May 1966).

The A_2 coefficient of the beta-gamma angular correlation for the cascade $2^-(\beta^+)2^+(\gamma)0^+$ in the positron decay of ^{74}As to ^{74}Ge was measured as a function of energy. The values found are 0.015 ± 0.006 at W = 1.8, 0.019 ± 0.004 at W =

2.0, 0.030 ± 0.005 at W = 2.1, and 0.025 ± 0.005 at W = 2.2, where the energy W is measured in mc^2 units. The data were used to examine the structure of the first excited level in ^{74}Ge, using the modified B_{ij} approximation. Four shell-model configurations, as well as a rotational excitation, were found to fit the experimental data. The validity of the application of the modified B_{ij} approximation to this decay is discussed. (auth)

28306 EXCITATION CURVES FOR THE (n,2n), (n,p), AND (n,nα) REACTIONS OF ^{65}Cu. Santry, D. C.; Butler, J. P. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys., 44: 1183-93(May 1966). (AECL-2421).

Cross sections for the reactions $^{65}Cu(n,2n)^{64}Cu$, $^{65}Cu(n,p)^{65}Ni$, and $^{65}Cu(n,n\alpha)^{61}Co$ were measured by the activation method from threshold energies up to 20.2 Mev. The measurements are relative to the known cross section for the reaction $^{32}S(n,p)^{32}P$. The (n,2n) cross-section curve increases smoothly with energy and reaches a maximum value of 1.085 ± 60 mb at about 18 Mev. The (n,p) reaction reaches a maximum value of 21.7 ± 1.2 mb at 13.9 Mev. The (n,nα) reaction has a minimum detectable value of 0.3 ± 0.1 mb near 14 Mev and increases to a value of 18.9 ± 0.9 mb at 19.8 Mev. Effective cross-section values for a fission-neutron spectrum calculated from these results are 0.251 ± 0.018 mb for the (n,2n) reaction and 0.523 ± 0.030 mb for the (n,p) reaction. (auth)

28307 COULOMB CORRECTION TERM IN THE OPTICAL MODEL POTENTIAL FOR PROTON SCATTERING. Sood, P. C. (Univ. of Alberta, Edmonton). Can. J. Phys., 44: 1203-6(May 1966).

Evidence for the existence of a symmetry term in the analysis of elastic scattering of neutrons and protons from nuclei has been growing over the past few years. A detailed study is in progress of the problem with nonlocal interactions to determine the role and to indicate the procedure for the proper inclusion of the Coulomb correction term in the proton potential. There is an indication that although the nonlocal potential includes such a term, no such term need be introduced in the equivalent local potential. (AECL)

28308 STUDY OF THE ANGULAR DISTRIBUTIONS OF THE (n,α) REACTION ON ^{32}S FROM 2.5 TO 3.2 Mev. Chambon, Bernard; Billerey, Roland; Salin, Raymond; Depraz, Jean (Institut de Physique Nucleaire, Lyon). Compt. Rend., Ser. B., 262: 733-5(Mar. 7, 1966). (In French).

The angular distribution curves from the (n,α) reaction on ^{32}S were determined for 2.5 Mev ≤ $E_{\underline{n}}$ ≤ 3.2 Mev. (tr-auth)

28309 PRECISE MEASUREMENT OF THE RATIO OF THE NUCLEAR MAGNETIC MOMENTS OF ^{111}Cd AND ^{113}Cd ISOTOPES. Leduc, Michele; Lehmann, Jean-Claude (CNRS, Paris). Compt. Rend., Ser. B., 262: 736-9(Mar. 7, 1966). (In French).

The isotopes ^{111}Cd and ^{113}Cd were oriented nuclearly by optical pumping by the 3261 Å line, and the ratio of their nuclear resonance frequencies was measured in the same magnetic field. To improve the precision of the measurements, the magnetic field was placed at the resonance of one of the two isotopes studied. (tr-auth)

28310 MAGNETIC MOMENTS OF ^{135}Ba AND ^{137}Ba BEGINNING WITH THE HYPERFINE STRUCTURE OF THE RAY Ba II, λ 4934 A. Comaniciu, Nicolae; Draganescu, Vasile; Tatu, Vasile (Institut de Physique Atomique, Bucharest). Compt. Rend., Ser. B, 262: 915-18(Mar. 28, 1966). (In French).

The nuclear magnetic moments of ^{135}Ba and ^{137}Ba were determined from the hyperfine structure of Ba II, λ4923 Å, measured using a Fabry-Perot photoelectric spectrometer. The values $\mu_I(^{135}Ba) = 0.843 \pm 0.007\ \mu_N$ and $\mu_I(^{137}Ba) = 0.930 \pm 0.007\ \mu_N$ obtained, in good agreement with the values obtained from magnetic resonance, are calculated using an improved theory. (tr-auth)

28311 ERRORS ENCOUNTERED DURING MEASUREMENTS OF EMITTER ACTIVITY BY MEANS OF RELATIVE METHOD. Kostyleva, Yu. G. Izmeritel. Tekh., No. 12, 9-11(Dec. 1965). (In Russian).

The problem of random errors of measurements and of the optimum distribution of the total time of measurement among the times of measuring the count rate of sample plus background, of standard emitter plus background, and of background alone is examined. Equations are found for the minimum measurement error as a function of total measurement time and for the relative optimum times to be spent measuring the sample and the standard, if the background is known. (M.J.T.)

28312 PULSE METHODS IN HIGH RESOLUTION NUCLEAR MAGNETIC DOUBLE RESONANCE. Lippmaa, E.; Past, J.; Puskar, J.; Alla, M.; Sugis, A. (Inst. of Cybernetics, Academy of Sciences, Estonian SSR). Izv. Akad. Nauk Est. SSR, Ser. Fiz. Mat. Tekh. Nauk, No. 1, 51-7(1966). (In Russian).

Possibilities of time sharing methods in nuclear magnetic double resonance were investigated. The double resonance features of NMR spectrum depend upon the transmitter pulse repetition rate ω_m and relaxation times. If $\tau \ll 2\pi/\omega_m \ll T_{2r}^*, T_{2s}^*, T_{1r}$ where τ is the time constant of loaded coil, T_{2r}^* and T_{1r} are transverse and longitudinal relaxation times of spectral lines being investigated and T_{2s}^* is the transverse relaxation time of the perturbed line, then all double resonance effects (especially tickling and collapse) are exhibited in a normal way, but overall apparatus stability is greatly increased. A suitable spin-stabilized spectrometer arrangement for double resonance time sharing work is described. (auth)

28313 ^{13}C NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY. II. APPLICATION OF THE TIME SHARING METHOD. ^{13}C NMR-SPECTROMETRY AT ELEVATED TEMPERATURES. Lippmaa, E.; Past, J.; Olivson, A.; Saluvere, T. (Inst. of Cybernetics, Academy of Sciences, Estonian SSR). Izv. Akad. Nauk Est. SSR, Ser. Fiz. Mat. Tekh. Nauk, No. 1, 58-63(1966). (In Russian).

It was shown that the time sharing method with a high (6 kc) pulse repetition rate is very appropriate for ^{13}C NMR-spectrometry and allows elevated temperatures to be used. A pulse spectrometer with a variable temperature head is described. The chemical shifts of some quinone carbonyl carbons were investigated and were found to fall into the +8 to +12 ppm from CS_2 range. Relative intensities of the two lines in benzene doublet were found to have a strong temperature dependence. (auth)

28314 WEAK PERTURBING RADIO-FREQUENCY FIELD EFFECTS IN NUCLEAR MAGNETIC DOUBLE RESONANCE. [PART] II. Sinivee, V.; Lippmaa, E. (Inst. of Cybernetics, Academy of Sciences, Estonian SSR). Izv. Akad. Nauk Est. SSR, Ser. Fiz. Mat. Tekh. Nauk, No. 4, 564-8(1965). (In Estonian).

The shape of spectral lines without a common energy level with perturbed line is discussed. A weak splitting of these lines occurs in inhomogeneous constant magnetic field in a frequency-swept spectrum. This splitting disappears with further increase of the strength of the perturbing r-f field. Field inhomogeneity-independent relations between relaxation parameters and line intensities are given. (auth)

28315 GAMMA-RAY TRANSITIONS ASSOCIATED WITH THE DECAY OF ^{94}Y AND ^{95}Y. Fiedler, H. J.; Kennett, T. J. (McMaster Univ., Hamilton, Can.). J. Inorg. Nucl. Chem., 28: 1129-34(May 1966).

The γ transitions resulting from the β decay of ^{94}Y and ^{95}Y were studied using a large Ge(Li) counter. A total of 33 transitions was found and were readily associated with either ^{94}Y or ^{95}Y. Decay schemes of the ^{94}Zr and ^{95}Zr levels populated by the decay of ^{94}Y and ^{95}Y are proposed. (auth)

28316 SOME CROSS-SECTIONS FOR THE INELASTIC SCATTERING REACTION $^{180}Hf(p,p'\gamma)^{180m}Hf$ WITH 16-62 Mev PROTONS. Hageboe, E.; Boge, R. (Univ. of Uppsala). J. Inorg. Nucl. Chem., 28: 1135-41(May 1966).

Cross sections for the reaction $^{180}Hf(p,p'\gamma)^{180m}Hf$ were measured radiochemically in the energy range from 16 to

62 Mev. The results are discussed in the light of Monte Carlo calculations performed by Bertini on the same system of target and range of proton energies, and seem to imply a pure direct interaction mechanism. (auth)

28317 MAGNETIC MOMENT OF ^{17}F—NUCLEAR MAGNETIC RESONANCE BY POLARIZATION FOLLOWING ^{16}O(d,n)^{17}F REACTION. Sugimoto, Kenzo; Mizobuchi, Akira; Nakai, Kozi; Matuda, Kozi (Osaka Univ.). J. Phys. Soc. Jap., 21: 213-21(Feb. 1966).

The nuclear magnetic resonance of ^{17}F ($T_{\frac{1}{2}}$ = 66 sec) was observed using the polarization of recoil nuclei produced by the reaction ^{16}O (d,n)^{17}F and the β-decay anisotropy as the indicator of the polarization. The accomplishment of the experiment was essentially due to the persistence of the polarization by specific experimental methods, i.e., the use of strong magnetic field ($\gtrsim$5kG) in the direction of polarization and the use of pure CaF_2 crystals as the stopping material of recoil ions. The observed asymmetry of β-counting was about 2% and a spin relaxation time T_1 comparable to the half life of ^{17}F was observed. The value obtained of the magnetic moment of ^{17}F is μ = 4.7224 ± 0.0012 nm with the diamagnetic correction. (auth)

28318 SUPERIORITY OF ATOMIC MASS PER NUCLEON AS A PARAMETER FOR NUCLIDES RATHER THAN THE CONVENTIONAL PACKING FRACTION. Klepp, Harald B. (Royal Norwegian Naval Academy, Bergen). Nature, 209: 1344-5(Mar. 19, 1966).

The ambiguity of the packing fraction as a parameter for nuclides is discussed. The use of the atomic mass per nucleon as a parameter for nuclides, so as to free calculations from any dependence on particular standards of atomic masses, is presented. (B.G.D.)

28319 ASYMMETRIC NUCLEAR FISSION AND THE LIQUID DROP MODEL. Ryce, S. A. (Univ. of Victoria, British Columbia, Can.). Nature, 209: 1343-4(Mar. 26, 1966).

A discussion on the resemblance between curves representing the division of electrically charged liquid drops and mass yield curves for nuclear fission is presented. The use of the liquid drop model of the nucleus to explain the asymmetry of nuclear fission is also discussed. (B.G.D.)

28320 NUCLEAR CROSS SECTIONS FOR CHARGED-PARTICLE-INDUCED REACTIONS: Li, Be, B. Kim H. J.; Milner, W. T.; McGowan, F. K. (Oak Ridge National Lab., Tenn.). Nucl. Data, Sect. A, 1: 203-389(Apr. 1966).

Nuclear cross sections for charged-particle-induced reactions of isotopes of Li, Be, and B are presented in tabular and graphical form. This compilation includes experimental cross-section data available in the literature before January 1, 1964, for nuclear reactions of the type A(a,b)B at all energies, where $M_a \geq$ one nucleon mass. Nuclear reactions involving mesons in the exit channel are not included. This collection supplements a previous compilation, Los Alamos Scientific Laboratory Report LA-2014. A large amount of the cross-section data is not presented either in tabular or graphical form in order to limit the size of the present compilation to a manageable one. A number of annotated bibliographies are included to provide a brief summary of these data. (auth)

28321 SYMMETRY DEFECTS IN POLARIZATION MEASUREMENT. Libert, J. (Institut Interuniversitaire des Sciences Nucleaires, Mons, Belg.). Nucl. Instrum. Methods, 41: 348-54(1966). (In French).

The result of a polarization determination depends on the possible influence of symmetry defects due to an imperfect experimental set-up. This problem is presented in a general way. The usual methods of measurement are discussed and their properties, appearing in the literature in an unprecise and incomplete manner, are established rigorously. (auth)

28322 CONVERSION FUNCTION FOR CALCULATING ELASTIC SCATTERING ANGULAR DISTRIBUTIONS. Nurzynski, J. (Australian National Univ., Canberra). Nucl. Instrum. Methods, 41: 89-92(Apr. 1966).

A conversion function, denoted as $F(x,\theta)$ has been calculated and is tabulated for a range of values of x and for the laboratory angles θ up to 180°. The use of the tables makes possible an easy conversion of the measured intensity of the elastically scattered particles to the ratio σ/σ_R, where σ is the differential cross section for the elastic scattering and σ_R is the Rutherford scattering cross section. (auth)

28323 TRIPLE CORRELATION MEASUREMENTS ON ^{50}Cr. Twin, P. J.; Willmott, J. C. (Univ. of Liverpool). Nucl. Phys., 78: 177-92(1966).

The triple correlation method was used to measure the spins of some of the excited states of ^{50}Cr. States at 2.94, 3.18, 3.64, and 3.72 Mev were assigned a spin of 2 and those at 1.90 and 3.35 Mev a spin of 4. (auth)

28324 CALCULATION OF THE TIN ISOTOPES USING REALISTIC NUCLEON-NUCLEON INTERACTIONS. Kuo, T. T. S. (Univ. of Pittsburgh. Princeton Univ., N. J.); Baranger, Elizabeth; Baranger, Michel. Nucl. Phys., 81: 241-67(1966).

Shell-model matrix elements are calculated for Tabakin's two-nucleon interaction, which is a sum of separable potentials fitted to the nucleon-nucleon scattering data up to 320 Mev and designed to be used in Hartree-Fock calculations. It is shown that p states make a substantial contribution to the pairing matrix elements, in some cases larger than the contribution of s states. The matrix elements are compared with those calculated by Kuo using the Hamada-Johnston potential, and there is remarkable numerical agreement. A quasi-particle calculation is made with these matrix elements to study the low-lying states of the tin isotopes. The results are that, when only the usual five single-particle states are included, the odd-even mass difference is roughly half the experimental value; when more configuration mixing is included by allowing excitation of the core and permitting higher levels to be partially filled, satisfactory agreement is attained with the experimental odd-even mass difference, with the low-energy spectra of the odd isotopes and with changes in separation energies. (auth)

28325 ELASTIC SCATTERING OF 12 Mev TRITONS FROM LIGHT NUCLEI (A ≤ 40). Glover, R. N. (Atomic Weapons Research Establishment, Aldermaston, Eng.); Jones, A. D. W. Nucl. Phys., 81: 268-76(1966).

Triton elastic scattering angular distributions were measured at 12 Mev incident energy for ^{24}Mg, ^{25}Mg, ^{26}Mg, ^{27}Al, ^{35}Cl, ^{37}Cl and ^{40}Ca. Optical model analyses of varying complexity were carried out. It is concluded that at present a simple analysis using three variables, U, W_v and a, gives a reasonable description of triton elastic scattering. (auth)

28326 DWBA ANALYSIS OF (t,p) REACTIONS. Glover, R. N. (Atomic Weapons Research Establishment, Aldermaston, Eng.); Jones, A. D. W. Nucl. Phys., 81: 277-88(1966).

Zero-range DWBA double stripping theory is shown successfully to account for angular distributions observed from (t,p) reactions on ^{12}C, ^{16}O, ^{24}Mg, ^{28}Si and ^{40}Ca if the real triton potential is taken to be approximately equal to the sum of the potentials of its constituent nucleons. It is demonstrated from simple theoretical considerations that for the (t,p) reaction zero-range is expected to be a reasonable approximation except for very light nuclei. (auth)

28327 ABSOLUTE CROSS SECTIONS FOR STRIPPING REACTIONS. Glover, R. N. (Atomic Weapons Research Establishment, Aldermaston, Eng.); Jones, A. D. W.; Rook, J. R. Nucl. Phys., 81: 289-95(1966).

The absolute cross sections for (t,d) and (t,p) reactions are calculated using a simple wave function to describe the motion of the nucleons in the triton. In both cases reasonable agreement with the experimental data is obtained. (auth)

28328 DECAY OF ^{75}Se. Rao, P. Venugopala; McDaniels, D. K.; Crasemann, Bernd (Univ. of Oregon, Eugene). Nucl. Phys., 81: 296-304(1966). (RLO-1921-5).

The gamma-ray spectrum of ^{75}Se was studied with a high-resolution Ge(Li) spectrometer. Intensities (indicated in

parentheses) of 12 lines and the energy of three lines above 401 kev were measured: 66.05 kev (1.64 ± 0.05), 96.74 kev (5.33 ± 0.16), 121.12 kev (27.8 ± 0.8), 135.99 kev (94.9 ± 2.0), 198.60 kev (2.28 ± 0.05), 264.62 kev (100), 279.57 kev (43.0 ± 0.9), 304.0 kev (2.39 ± 0.05), 400.7 kev (22.3 ± 0.5), 419.6 ± 0.5 kev [$(3.22 \pm 0.06) \times 10^{-2}$], 572.0 ± 0.5 kev [$(6.36 \pm 0.13) \times 10^{-2}$] and 617.7 ± 0.5 kev [$(7.77 \pm 0.15) \times 10^{-3}$]. Total K x-ray intensity and capture branching ratios were determined: (5.8 ± 1.8)% of all decays are found to lead to the ground state of ^{75}As. The K-capture probability to the 401 kev level was measured as $P_K/P_{total} = 0.885 \pm 0.018$, in close agreement with the theoretical value of 0.88 computed after the theory of Brysk and Rose with allowance for electron exchange according to Bahcall. (auth)

28329 THE ^{7}Li + d → α + α + n REACTION. Assimakopoulos, P. A.; Gangas, N. H.; Kossionides, S. (Nuclear Research Centre Democritus, Attikis, Greece). Nucl. Phys., 81: 305-21(1966).

The reaction ^{7}Li + d → α + α + n is studied at deuteron bombarding energy 0.380 Mev. The ^{9}Be compound nucleus is formed with an excitation around 17 Mev. The two α-particles are detected in coincidence by two solid state detectors. Thus, the kinematics of the reaction are completely determined and discrimination between sequential two-body decay and direct three-body decay is possible. The reaction mechanism is found to be sequential two-body decay involving the ground and broad first excited states of ^{5}He. Contributions from the direct three-body decay and the sequential two-body decay involving the ^{8}Be, $J^\pi = 4^+$ second excited state, if at all present, are not more than a few percent of the total reaction output. Kinematically possible contributions from the ^{8}Be ground, $J^\pi = 0^+$ and the 2.9 Mev, $J^\pi = 2^+$ excited state fall within the energy region excluded by the apparatus. (auth)

28330 EXCITATION FUNCTIONS FOR THE REACTIONS INDUCED BY DEUTERONS ON ^{142}Ce UP TO 14.2 Mev. Otozai, K. (Osaka Univ.); Kume, S.; Koyama, M.; Mitsuji, T.; Nishi, T.; Fujiwara, I. Nucl. Phys., 81: 322-38(1966).

The excitation functions for the reactions ^{142}Ce(d,p)^{143}Ce, ^{142}Ce(d,n)^{143}Pr, ^{142}Ce(d,2n)^{142}Pr and ^{142}Ce(d,α)^{140}La were measured radiochemically up to a deuteron energy of 14.2 Mev. The results were well explained with a modified Peaslee theory on deuteron reactions, in which a new parameter, "entire absorption," was introduced. The figures, which show quantitatively the contributions of the stripping and the entire absorption process for each reaction, and the contributions of the n-stripping, the p-stripping and the entire absorption process for the ^{142}Ce + d interaction, were given. In the course of the experiment the half life of ^{142}Pr was determined to be 19.14 ± 0.05 hr. (auth)

28331 MICROSCOPIC THEORY OF ^{4}He AND ^{3}He SCATTERING BY EVEN-MASS NUCLEI. Ceuleneer, R. (Univ., Libre, Brussels). Nucl. Phys., 81: 339-48(1966).

The formal expressions of the scattering amplitudes for ^{4}He and ^{3}He scattering are derived in the framework of the distorted wave Born approximation. The nuclear states are described by means of the quasi-boson model. The phase rules corresponding to the excitation of the one-boson states are obtained using the properties of the radial integrals and without an explicit evaluation of the distortion parameters of the incoming and the outgoing waves. The possibility of a significant calculation of the magnitude of the cross sections is discussed. (auth)

28332 MICROSCOPIC THEORY OF α-SCATTERING BY ODD-MASS NUCLEI. Ceuleneer, R. (Univ. Libre, Brussels). Nucl. Phys., 81: 349-52(1966).

The formal expression of the DWBA scattering amplitude for inelastic α scattering by odd-mass nuclei whose states are described through a quasi-particle model is presented. This description is compared with the diffraction model. (auth)

28333 ELASTIC NEUTRON SCATTERING ON ^{12}C. Lovas, I. (Univ. of Copenhagen). Nucl. Phys., 81: 353-69(1966).

The elastic scattering of neutrons on ^{12}C was studied up to 4.5 Mev using Feshbach's unified reaction theory. The intermediate states were obtained from the shell-model calculation using a zero-range residual interaction. The coupling between the intermediate and continuum states was described by the same residual interaction. The calculated energies, widths and spin values of the resonances, as well as the absolute value of the cross section, all agree quite well with the experimental data. The only free parameter used in this calculation was the strength of the spin-orbit interaction. The lowest two intermediate states, which are approximately degenerate in the shell-model scheme, appear as two well separated resonances in the cross section due to the coupling between the intermediate and continuum states. (auth)

28334 NUCLEAR RESONANCE FLUORESCENCE AND THE SLOWING DOWN OF RECOIL NUCLEI IN MATTER. Skorka, S. J.; Evers, D.; Hertel, J.; Morgenstern, J.; Retz-Schmidt, T. W.; Schmidt, H. (Univ., Hamburg). Nucl. Phys., 81: 370-86(1966).

Nuclear resonance fluorescence scattering was observed to measure the lifetimes of the first excited states in ^{23}Na(0.440 Mev), ^{24}Mg(1.368 Mev), ^{28}Si(1.772 Mev), and ^{31}P(1.265 Mev). Inelastic proton scattering at energies between 1.8 and 3.2 Mev in solid targets served as a Doppler-broadened gamma source. The intensity of resonant gamma rays, which strongly depends on the energy loss of the excited recoils in the target, was calculated using average nuclear and electronic stopping powers of Lindhard and Scharff for heavy nuclear particles. The resonance scattering experiments yielded for ^{23}Na(0.440 Mev): $t_m = 1.62 \pm 0.10$ psec, ^{24}Mg(1.368 Mev): $t_m = 1.95 \pm 0.26$ psec, ^{28}Si(1.772 Mev): $t_m = 0.71 \pm 0.10$ psec, ^{31}P(1.265 Mev): $t_m = 0.74 \pm 0.10$ psec. These results are in excellent agreement with other data on the different lifetimes. In addition they confirm the Lindhard theory of nuclear stopping power to within at least 25% in the energy region $\epsilon = 10^{-3} - 10^{-1}$, where range measurements become difficult. The method of evaluating NRF scattering experiments with solid sources in the 0.01–10 psec lifetime region is described in detail. (auth)

28335 INTEGRALS FOR THE ALPHA PARTICLE. Roberts, P. J. (Univ. of Glasgow). Nucl. Phys., 81: 387-9(1966).

The energy integrals encountered with exponential four-particle wave functions and central, Yukawa-type, two-body potentials are reduced to three-dimensional quadratures. Coulomb and exponential potentials can be dealt with in the same way. Hard-core potentials are not discussed. (auth)

28336 LEVELS OF ^{48}Ti OBSERVED BY THE (d,α) REACTION ON ^{50}V. Dorenbusch, W. E. (Massachusetts Inst. of Tech., Cambridge); Hansen, Ole; Pullen, D. J.; Belote, T. A.; Sidenius, G. Nucl. Phys., 81: 390-400 (1966). (MIT-2098-215).

The ^{50}V(d,α)^{48}Ti reaction was examined at 7.50-Mev bombarding energy with a resolution of 15 to 25 kev. Measurements were performed at several angles between 30 and 165°. Energy levels, several of which are new, up to 5.7 Mev of excitation were identified. The relation between observed (d,α) cross sections and final state spins is examined. It is suggested that those ^{48}Ti levels which are strongly excited in the (d,α) reaction have spins between 6 and 10. (auth)

28337 RADIATIVE CAPTURE, PARTICLE EMISSION, AND FISSION IN HEAVY NUCLEI. Lessler, R. M.; Gibson, W. M.; Glass, R. A. (Univ. of California, Berkeley). Nucl. Phys., 81: 401-16(1966). (UCRL-16421).

Cross sections were determined radiochemically following bombardments of ^{234}U, ^{235}U, ^{236}U, ^{238}U and ^{239}Pu with 5–25 Mev deuterons and ^{237}Np with 20–50 Mev helium ions. Although fission accounts for most of the reaction cross section for all target isotopes, products from radiative capture and various spallation reactions were observed. Products corresponding to the (d,γ) reaction were observed from ^{238}U and other uranium isotopes, with a cross section

of about 1 mb. Both compound-nucleus and direct-interaction characteristics are apparent in the spallation excitation functions. The uranium (d,2n), (d,3n) and (d,4n) excitation functions show a "mass" effect; that is, the heavier target isotopes have generally higher spallation-product yields. This corresponds to a neutron partial-level width ratio $\Gamma_n/(\Gamma_n + \Gamma_f)$ increasing with N. Results from ^{239}Pu + d and $^{237}Np + \alpha$, both of which form the compound system $^{241}Am^*$, are consistent with the compound nucleus theory, in that (d,2n) and (d,3n) excitation functions correlate with $(\alpha,2n)$ and $(\alpha,3n)$ excitation functions. Direct interaction features include (d,n) stripping and a prominent $(\alpha,\alpha n)$ reaction in ^{237}Np. Yield curves and fission cross sections have been obtained to characterize the fission reaction. (auth)

28338 K-SHELL INTERNAL CONVERSION COEFFICIENT MEASUREMENT FOR THE 145 kev TRANSITION IN ^{141}Pr. Pancholi, S. C. (Univ. of Groningen, Netherlands). Nucl. Phys., 81: 417-22(1966).

The K-shell internal conversion coefficient for the 145 kev l-forbidden M1 transition in ^{141}Pr was measured by comparing the intensities of K x rays and γ rays. The absorption of K x rays and γ rays in the absorbing material of the crystal package was determined experimentally. A value of $\alpha_K = 0.376 \pm 0.007$ was obtained for the transition. Possible nuclear structure effects are discussed. The ratio of electron penetration matrix element to normal γ-ray matrix element obtained is $+5.0 \geqq \lambda_{small} \geqq -0.4$. (auth)

28339 STUDY OF ^{18}O BY 21.4 Mev ALPHA-PARTICLE SCATTERING. Lutz, H. F.; Eccles, S. F. (Univ. of California, Livermore). Nucl. Phys., 81: 423-32(1966). (UCRL-14584).

The elastic and inelastic scattering of 21.4 Mev alpha particles by ^{18}O was measured. The elastic angular distribution was fitted using the nuclear optical model. The potential thus obtained was employed in a DWBA calculation and values of $\beta_l R$ were obtained for the 1.98 Mev level ($J^\pi = 2^+$; $\beta_2 R$ = 0.99 fm), the 3.92 Mev level ($J^\pi = 2^+$; $\beta_2 R$ = 0.62 fm) and the 5.09 Mev level ($J^\pi = 3^-$; $\beta_2 R$ = 1.33 fm). The 4.45 Mev level and the 6.19 Mev level were strongly excited but could not be fitted with the usual one-step DWBA calculation. (auth)

28340 THE 1.08 AND 2.10 Mev LEVELS OF ^{18}F. Chagnon, P. R. (Univ. of Notre Dame, Ind.). Nucl. Phys., 81: 433-41(1966).

In the reaction $^{16}O(^3He,p\gamma)^{18}F$ at ^3He energies of 3.58 and 4.0 Mev, directional pγ correlations of five transitions involving the 1.08 and 2.10 Mev levels of ^{18}F were measured. From these the spin of the 2.10 Mev level is deduced to be 2 and that of the 1.08 Mev level to be 0. These two levels have like parities, and their parity is probably negative. Branching ratios and multipole mixtures were also measured. (auth)

28341 A STUDY OF ^{123}Sb LEVELS POPULATED IN THE BETA DECAY OF THE HIGH SPIN ISOMER OF ^{123}Sn. Auble, R. L.; Kelly, W. H. (Michigan State Univ., East Lansing). Nucl. Phys., 81: 442-8(1966).

Several nuclear energy levels in ^{123}Sb populated by the β^- decay of 125 d ^{123}Sn were examined. The presence of two states at 1032 and 1089 kev was deduced from studies utilizing a Ge(Li) gamma-ray spectrometer and a third state, at 1187 kev, was proposed on the basis of gamma-ray coincidence measurements. The β^- spectrum to the 1089 kev state was studied by means of a 4π plastic scintillator operating in coincidence with a NaI(Tl) gamma-ray spectrometer. A Fermi-Kurie plot of the spectrum was found to be linear indicating that the transition is either allowed or nonunique first forbidden. The log ft value of 9.0 found for this transition tends to support the latter assignment. (auth)

28342 DECAY SCHEME OF ^{58}Ni FROM (p′,γ) COINCIDENCE STUDIES AT 8.0 Mev. Hinrichsen, P. F. (Univ. of Pennsylvania, Philadelphia); Wood, G. T.; Shafroth, S. M. Nucl. Phys., 81: 449-67(1966). (NYO-1679-15).

The gamma rays from the $^{58}Ni(p,p'\gamma)^{58}Ni$ reaction at E_p = 8.0 Mev were studied with a Li-Ge counter and by particle-gamma-ray coincidence measurements using a two-dimensional pulse-height analyzer. The major decay modes of the first 14 levels were established and gamma-ray intensity ratios for a fixed geometry were determined. (auth)

28343 ANGULAR DISTRIBUTIONS OF GAMMA RAYS IN (n,n′γ) REACTIONS AS A BASIS FOR NUCLEAR LEVEL SPINS. Mathur, S. C.; Buchanan, Patricia S.; Morgan, I. L. (Texas Nuclear Corp., Austin). Nucl. Phys., 81: 468-80(1966).

A computer program TRANSEC based on Satchler theory was developed for the theoretical calculation of the differential cross sections for the production of gamma rays in (n,n′γ) reactions. The code is sufficiently versatile to take into account multiple exit channels, gamma-ray cascades, mixed multipolarities and an arbitrary number of sets of transmission coefficients. Comparisons between the experimental angular distributions and the theoretically calculated distributions lead to information regarding the level spins and the mixing ratios of the various gamma-ray transitions. The predictions of the Satchler theory are in excellent agreement with the experimental cross sections measured for the ^{24}Mg, ^{26}Mg, ^{27}Al, ^{28}Si, ^{40}Ar, ^{40}Ca, ^{54}Fe, ^{56}Fe, ^{59}Co, ^{89}Y and ^{208}Pb nuclei. This method was used for the assignment of level spins in the ^{27}Al, ^{40}Ar, ^{59}Co and ^{89}Y nuclei. The sensitivity of the distributions and the cross sections to the assumed parities of the nuclear levels was also investigated. (auth)

28344 NUCLEAR SPECTROSCOPY OF NEUTRON-DEFICIENT HAFNIUM AND RARE EARTH ACTIVITIES. Harmatz, B.; Handley, T. H. (Oak Ridge National Lab., Tenn.). Nucl. Phys., 81: 481-522(June 1966). (ORNL-P-1862).

A spectrographic survey was made of transitions converting in lutetium isotopes in the mass interval $168 \leqq A \leqq 175$. Partial decay schemes are deduced from energy sums, multipolarities and intensities of the transitions. The proposed excited states are described using the Mottelson and Nilsson predictions. The amount of experimental information appears sufficient to justify an analysis for systematic properties of intrinsic states and of the associated rotational bands. Previous assignments in related nuclei are incorporated in the energy-level systematics. More complete conversion electron measurements permit extension of nuclear level structures of ^{173}Yb, ^{157}Gd, ^{149}Eu and ^{151}Eu. For the decay of $^{133}La \rightarrow {}^{133}Ba$, an energy-level diagram is proposed which accounts for most of the radiation intensity. (auth)

28345 NEW LEVELS IN ^{43}Sc. Cujec, Bibijana (Univ., Laval, Can.). Nucl. Phys., 81: 523-8(June 1966).

The reaction $^{40}Ca(\alpha,p)^{43}Sc$ was studied at 9 and 10 Mev incident energy. The energy levels of ^{43}Sc were determined with a high resolution magnetic spectrograph up to 2.1 Mev excitation. New levels were observed at 1.34, 1.41, 1.64, 1.88, and 1.91 Mev. The reaction mechanism and the nature of the low-lying ^{43}Sc levels are discussed. (auth)

28346 STUDY OF NUCLEAR EXCITATIONS IN ^{10}B, ^{11}B, AND ^{14}N BY INELASTIC ELECTRON SCATTERING AT 180 DEG. Kossanyi-Demay, P.; Vanpraet, G. J. (Stanford Univ., Calif.). Contract [Nonr 225(67)]. Nucl. Phys., 81: 529-47(June 1966).

A study is made of nuclear energy states in ^{10}B, ^{11}B, and ^{14}N by means of inelastic electron scattering at 180°. Radiation widths were derived for the excited states and the results are compared with the single-particle model predictions. For the magnetic dipole transitions in ^{10}B and ^{11}B a comparison is made of the experimental data with recently calculated M1 transition strengths in p-shell nuclei by Cohen and Kurath. (auth)

28347 A COINCIDENCE SPECTROMETER METHOD FOR MEASURING THE K-CAPTURE PROBABILITY APPLIED TO ^{111}In. Sparrman, P.; Sundstroem, T.; Marelius, A. (Univ. of Uppsala). Nucl. Phys., 81: 548-56(June 1966).

A new method for measuring K-capture probabilities is described. The experimental requirements for the method are a coincidence beta spectrometer, a fast coincidence circuit and a time-to-pulse-height converter. The method is applicable with high precision in several nuclides and also in cases where the subsequent deexcitation of the daughter nucleus involves appreciable internal conversion. The method is illustrated by a measurement of the K-capture probability for ^{111}In. The result is 86.7 ± 0.7% K-capture probability in agreement with the theoretical value including the correction for exchange and overlap effects. (auth)

28348 MUON CAPTURE RATES IN COMPLEX NUCLEI. Eckhause, M. (Coll. of William and Mary, Williamsburg, Va.); Siegel, R. T.; Welsh, R. E.; Filippas, T. A. Nucl. Phys., 81: 575-84(June 1966). (TID-22367).

Total disappearance rates of negative muons brought to rest in 30 elements were measured to 1-2% precision. The experimental procedure and the results obtained are presented. In addition, a compilation of all measurements of muon capture rates in complex nuclei as presently known is given, and several analytical fits to these rates are discussed. (auth)

28349 ON THE STABILITY OF THE HYPERNUCLEUS $^{6}_{\Lambda}$He. Willain, C. (Univ. Libre, Brussels). Nucl. Phys., 81: 585-95(June 1966).

The result of an analysis of the $^{6}_{\Lambda}$He hypernucleus in a three-body model alpha-neutron and hyperon Λ^0 is reported. This analysis is carried out by a variational calculation using a trial radial wave function of the exponential form. For the description of $^{6}_{\Lambda}$He a Yukawa Λ-nucleon potential, an exponential potential α-Λ given by Bodmer and Ali in a study of $^{5}_{\Lambda}$He and the α-n potential used in the phase-shift analysis of p-α scattering data were used. The results of a variational calculation using those hypotheses is that the $^{6}_{\Lambda}$He hypernucleus is bound by 2 Mev against decay into neutron + $^{5}_{\Lambda}$He. (auth)

28350 CASCADE CURVES FOR XENON. Jablonski, Zdzislaw (Univ. of Lodz, Poland). Nucl. Phys., 81: 620-2(June 1966).

Electron-photon cascade curves are given for the energy interval 5.76×10^{7} ev-2×10^{10} ev for the cases when an electron or a photon initiates the cascade, and for different values of the minimum energy. (auth)

28351 π^- ABSORPTION BY UNCORRELATED NUCLEONS IN ^{16}O. LeTourneux, Jean (Univ. of Virginia, Charlottesville). Nucl. Phys., 81: 665-72(June 1966).

A study is made of the absorption from rest of π^- mesons by uncorrelated nucleons in ^{16}O. The absorption probability is calculated for pions in the 1s and 2p orbits. The non-relativistic pion-nucleon interaction contains two terms, one of them involving the momentum of the nucleon, the other the momentum of the pion. The neglect of the latter is shown to be an unjustified procedure in the study of the absorption process. From the results of the present calculation, the absorption of a 2p pion by uncorrelated nucleons appears to be highly hindered with respect to the absorption process by a correlated pair, as could be expected from conservation principles. (auth)

28352 ISOMER RATIOS FOR THE ^{41}K(α,n)^{44,44m}Sc AND ^{55}Mn(α,n)^{58,58m}Co REACTIONS. Keedy, Curtis R. (Univ. of Wisconsin, Madison); Haskin, Larry; Wing, James; Huizenga, J. R. Nucl. Phys., 82: 1-15(1966).

Cross-section ratios for the isomeric pairs ^{44}Sc, ^{44m}Sc and ^{58}Co, ^{58m}Co produced from the ^{41}K(α,n) and ^{55}Mn(α,n) reactions, respectively, were measured as a function of alpha-particle energy. Since the alpha particles were produced in a tandem Van de Graaff accelerator, the energy scale was well established. The experimental results were compared with calculations based on different nuclear models in order to study the spin dependence of the nuclear level density. With a level density parameter a = 5 Mev^{-1}, calculations based on a superconductor model agree very well with the experimental data for ^{44}Sc, while calculations with a Fermi-gas model require a moment of inertia at lower excitation energies of about ⅔ the rigid-body value. On the other hand, Fermi-gas calculations for another odd nucleus ^{58}Co require a rigid-body moment of inertia at low excitation energies. Modified Fermi-gas and superconductor calculations predict a decrease in ^{44}Sc, ^{44m}Sc isomer ratios from the ^{41}K(α,n) reaction at very high bombarding energies. This result is qualitatively similar to the observed behavior. (auth)

28353 NEUTRON CROSS SECTIONS OF THE BORON ISOTOPES FOR ENERGIES BETWEEN 10 AND 500 kev. Mooring, F. P.; Monahan, J. E.; Huddleston, C. M. (Argonne National Lab., Ill.). Nucl. Phys., 82: 16-32(1966).

The total neutron cross sections of ^{10}B, ^{11}B, C, and O and the absorption cross section of ^{10}B have been measured for neutron energies between 10 and 500 kev. The ^{10}B absorption cross section does not deviate appreciably from a 1/v dependence in this interval of neutron energies. The present values of the ^{10}B absorption cross section are systematically larger than measured values of the ^{10}B(n,α) cross section; but the evidence presented indicates that this excess cannot be explained in terms of other neutron-absorbing reactions. (auth)

28354 ^{6}Li(α,γ)^{10}B REACTION AND THE ENERGY LEVELS OF ^{10}B. Forsyth, P. D.; Tu, H. T.; Hornyak, W. F. (Univ. of Maryland, College Park). Nucl. Phys., 82: 33-48 (1966).

The ^{6}Li(α,γ)^{10}B reaction has been studied between 0.9 and 3.3 Mev bombarding energy. Levels in ^{10}B at 5.11, 5.16, 5.92 and 6.02 Mev excitation were observed and γ-decay partial widths determined. Cross sections for the (α,γ) reaction proceeding via the 5.92 and 6.02 Mev levels have not previously been reported. The 5.11 Mev state was found to have branching ratios (64 ± 7), (31 ± 7) and (5 ± 5) % for the cascades to the ground, 0.72 and 1.74 Mev levels. The 5.16 Mev level has branching ratios (5 ± 1), (24 ± 3), (2 ± 1) and (69 ± 5) % for the cascades to the ground, 0.72, 1.74 and 2.15 Mev levels. The 5.92 Mev level has branches (82 ± 5) and (18 ± 5) % for the ground state and 0.72 Mev level transitions. The total width of the 5.92 Mev level was determined to be 6 ± 1 kev in the center-of-mass system. The 6.02 Mev state was found to decay only to the ground state, other branches being less than 3%. Limits for the (α,γ) reaction proceeding via possible resonances of ^{10}B at 5.58, 6.13-6.16 and 6.40 Mev were obtained. (auth)

28355 NUCLEAR FINITE SIZE EFFECTS ON THE ABSOLUTE ft VALUES FOR FIRST-FORBIDDEN TRANSITIONS OF THE ODD-MASS NUCLEI IN THE A > 220 REGION. Bogdan, D. (Inst. for Atomic Physics, Bucharest); Stefan, H.; Mihai, R. C. Nucl. Phys., 82: 49-51(1966).

The absolute ft values for the first-forbidden transitions of some transuranic odd-mass nuclei have been calculated. The results were obtained both in the Konopinski-Uhlenbeck approximation and by taking account of the nuclear finite size. It is found that in the case of the transitions ^{233}Pa($^{3}/_{2}^{-}$) → ^{233}U($^{1}/_{2}^{+}$), ^{225}Np($^{5}/_{2}^{+}$) → ^{225}U($^{7}/_{2}^{-}$) and ^{237}U($^{1}/_{2}^{+}$) → ^{237}Np($^{5}/_{2}^{-}$) the nuclear finite size effects decrease significantly the difference between the theoretical and experimental values. (auth)

28356 FOUR-PARAMETER COINCIDENCE STUDY OF THE ^{6}Li(^{6}Li,α)2α REACTION. Berkowitz, E. H. (Univ. of Iowa, Iowa City). Nucl. Phys., 82: 52-64(1966).

The ^{6}Li(^{6}Li,α)2α reaction was studied at $E_{^{6}Li}$ = 2.75 Mev. A four-parameter data acquisition system employing two position-sensitive surface-barrier detectors, four pulse-height analysers and a general-purpose computer, provided simultaneous measurement of coincident energy spectra for any pair of angles within the 40° angular intervals subtended by each detector. No statistically correlated component appears in the energy or angle correlations. Regions of the coincidence spectra which correspond to the intense continuum observed in singles spectra, were found to exhibit pronounced structure which varied rapidly with angle. Contributions to these spectra from the decay of high-lying excited states of ^{8}Be provide limited explanations for the observed structure. Angles and energies which satisfy the kinematic conditions for the zero momentum transfer of a

deuteron tend to coincide with the highest coincidence rates in the angular range covered, in accord with a simple direct reaction model. However, no single hypothesis based upon decay of states of ^{8}Be or a special reaction mechanism accounts for all of the observed structure. (auth)

28357 FISSION BARRIERS AND HALF-LIVES OF THE TRANS-RADIUM ELEMENTS. Viola, V. E. Jr.; Wilkins, B. D. (Argonne National Lab., Ill.). Nucl. Phys., 82: 65-90(1966).

Spontaneous fission half-lives and fission barriers are calculated for the elements with $88 \leqq Z \leqq 108$. The method is semi-empirical, based on the liquid drop model with modifications for the effects of nuclear structure. Spontaneous fission stability is predicted to decrease for nuclei just beyond the N = 152 neutron subshell, but should increase regularly for neutron numbers greater than 160. This effect should become quite strong as the N = 184 neutron subshell is approached, resulting in a number of experimentally observable isotopes in the mass region $A \approx 270-290$. The results are discussed briefly with regard to problems of nucleosynthesis as they pertain to the discovery of new isotopes and heavy element generation in stellar reactions. (auth)

28358 TWO-PHONON QUADRUPOLE-OCTUPOLE VIBRATIONS IN SPHERICAL NUCLEI. Lipas, P. O. (NORDITA, Copenhagen). Nucl. Phys., 82: 91-112(1966).

One-phonon quadrupole and octupole states in spherical nuclei are combined to give a quintet of close-lying states with spins 1^-, 2^-, 3^-, 4^-, 5^-. Quadrupole-octupole interactions, i.e., anharmonic potential terms coupling the two modes of excitation, are deduced from the requirement that the Hamiltonian be a scalar and Hermitian. Momentum-dependent terms are included. The level splittings are calculated in perturbation theory and by numerical diagonalization. The lowest-order interaction (cubic in the collective coordinates) gives the level order 4, 1, 5, 3, 2, with other locations also possible for the 3^-. The various fourth-order terms give the sequences 1, 5, 2, 3, 4; 1, 3 (degenerate), 5, 4, 2; 1, 2, 3, 4, 5 (rotational); 1, 4, 5, 2, 3. Any of these fourth-order spectra may be inverted. The B(E3) values for the excitation of the 3^- member of the quintet are also calculated. The natural parity states are known in ^{114}Cd, ^{148}Sm and ^{150}Sm, all having the order 1, 5, 3. To fit both the energies and the B(E3) values (known in ^{148,150}Sm) one needs both third and fourth orders in the interaction. More definite conclusions about the quadrupole-octupole interaction require more experimental data. (auth)

28359 STUDY OF THE 8.92 Mev → 0 TRANSITION IN ^{11}B AND THE 6.49 Mev → 0 IN ^{11}C. Gorodetzky, S.; Coffin, J. P.; Gallmann, A.; Frick, G.; Jundt, F. (Institut de Recherches Nucleaires, Strasbourg). Nucl. Phys., 82: 113-28(1966). (In French).

A Siegbahn-Slatis intermediate-image magnetic pair spectrometer has been changed into a multipolemeter with the purpose of determining the multipolarity of electromagnetic transitions. The ratio of the baffle in and baffle out measurements for the 8.92 Mev → 0 transition in ^{11}B and 6.49 Mev → 0 transition in ^{11}C shows that these transitions are M1 or E3 and E2, respectively. These results in connection with those of other authors lead us to attribute $J^\pi = 5/2^-$ for the 8.92 Mev level of ^{11}B and $J^\pi = 3/2^-$, $5/2^-$ or $1/2^-$ for the 6.49 Mev level of ^{11}C. (auth)

28360 CENTRAL AND TENSOR POTENTIALS IN NUCLEAR SHELL MODEL CALCULATIONS. Hughes, T. A.; Snow, R.; Pinkston, W. T. (Vanderbilt Univ., Nashville). Nucl. Phys., 82: 129-50(1966).

The results of an attempt to determine an effective interaction for nuclear shell-model problems are presented. A residual interaction with gaussian shape and both central and tensor parts was assumed. The ranges of these parts were fixed, but the strengths of the various spin-parity components were varied to obtain a good fit to a number of nuclear levels. The levels chosen for this fit were those in nuclei which consist of two particles or holes relative to the closed shell cores of ^{16}O, ^{40}Ca, ^{88}Sr, and ^{208}Pb. The attempt failed, in that no reasonable set of potential parameters could be found which worked reasonably well for all cases. The greatest success was obtained for those nuclei which have ^{208}Pb as the core, although one of the worst cases of disagreement was ^{206}Tl. (auth)

28361 ENERGY LEVELS OF ^{101}Ru FED IN THE ELECTRON CAPTURE DECAY OF ^{101m}Rh. De Aisenberg, E. Y.; Suarez, J. F.; Scheuer, W. (Comision Nacional de Energia Atomica, Buenos Aires). Nucl. Phys., 82: 151-60(1966).

Gamma-gamma coincidences and internal conversion electrons observed in the decay of ^{101m}Rh($T_{1/2}$ = 4.5 d) allow the establishment of transitions with energies (in kev) of 127.08 ± 0.08 (0.4 ± 0.1), 182 ± 2 (0.4 ± 0.1), 232 ± 7 (0.4 ± 0.1), 234 ± 5 (0.7 ± 0.3), 306.79 ± 0.07 (100), 359 ± 7 (≪0.4) and 541 ± 5 (6 ± 1). A level sequence of energies, 0, 127, 307, 359 and 541 kev with characteristics $5/2^+$, $3/2^+$, $7/2^+$, $(3/2, 5/2)$ and $(7/2, 9/2)^-$, respectively, is proposed. Two electron capture branches from the $(9/2^+)$ isomeric state of ^{101}Rh to the 307 kev and 541 kev levels, respectively, are consistent with the scheme. The isomeric transition of energy 157.26 ± 0.03 kev has a K/L/M ratio of 100/31/8. In the decay of ^{101}Rh(≈ 5 y) two transitions of energies 127.09 ± 0.09 and 197.9 ± 0.2 were detected. (auth)

28362 REACTIONS (d,p) ON ^{11}B, ^{12}C, ^{14}N, AND ^{16}O AT $E_d \leqq 5.5$ Mev. Gallmann, A. (Institut de Recherches Nucleaires, Strasbourg); Fintz, P.; Hodgson, P. E. Nucl. Phys., 82: 161-81(1966). (In French).

The differential cross sections for the following reactions have been measured at the energies indicated: ^{11}B(d,p)^{12}B (g.s. −0.95−1.67 and 2.62 Mev levels) at E_d = 5.5 Mev; ^{12}C(d,p)^{13}C (g.s.) at E_d = 1.2−1.3−1.7−2.5−4.0 and 4.5 Mev and ^{12}C(d,d_0)^{12}C at E_d = 4.0 Mev; ^{14}N(d,p)^{15}N (g.s.) at E_d = 1.3−2.6−3.5−4.45−5.0 and 5.5 Mev and ^{14}N(d,p)^{15}N (6.33 Mev level) at E_d = 1.3 and 4.5 Mev; ^{16}O(d,p)^{17}O (g.s. and 0.871 Mev level) at E_d = 1.3 and 4.0 Mev and ^{16}O(d,d_0)^{16}O at E_d = 4.0 Mev. A preliminary analysis of these cross sections is made using the distorted wave theory of the stripping reaction. (auth)

28363 STUDY OF THE ^{86}Kr(d,t)^{85}Kr AND ^{86}Kr(d,d')^{86}Kr REACTIONS. Rosner, Baruch; Schneid, E. J. (Univ. of Pittsburgh). Nucl. Phys., 82: 182-8(1966).

Low-lying levels of ^{85}Kr and ^{86}Kr were studied by the ^{86}Kr(d,t) and ^{86}Kr(d,d') reactions. The outgoing tritons and scattered deuterons were simultaneously detected using solid state detectors, in a particle identification arrangement. Angular distribution of the reaction products were taken between 20° and 90°. Many new levels in ^{85}Kr were observed and an $l_n = 1$ angular momentum transfer was assigned to the transition leading to the 1.12 Mev state. Six energy levels up to excitation energy of 3.5 Mev were observed in ^{86}Kr. The first 2^+ state in ^{86}Kr was found to be at 1.56 Mev. A comparison between the level structure obtained in this work and the proposed decay scheme of ^{86}Br is discussed. (auth)

28364 PAIRING CORRELATIONS IN ROTATIONAL STATES OF NUCLEI. Chan, K. Y.; Valatin, J. G. (Univ. of Birmingham, Eng.). Nucl. Phys., 82: 222-40(1966).

The interaction between pairing and nuclear rotation is investigated. A gap equation is derived in a rotating system valid to all orders in the angular velocity. Practical calculations are based on a perturbation expansion with respect to the explicit dependence on angular velocity. Corrections to the quasi-particle energies are calculated for a rotating nucleus. The single-particle states which enter into the best variational trial state vector of the Bardeen-Cooper-Schrieffer type are discussed. In the limit of a vanishing gap parameter these do not reduce to the shell model eigenstates of the rotating system. A critical rotational frequency Ω_c is determined from an equation of small oscillations. This is the same as the value of Ω obtained from the gap equation for which the gap parameter vanishes. A previously given coupling constant argument by Mottelson and Valatin (Phys. Rev. Lett., 5: 511(1960)) leads only to a lower bound to this critical frequency. Gap curves and the variation of the effective moment of inertia are calculated

for ^{180}Hf, using a harmonic oscillator shell-model potential. The gap curves in function of the angular velocity have a metastable part. Proton and neutron gaps change with rotation in a different way, and two critical regions are predicted. (auth)

28365 MIXING RATIO M1 + E2 AND PENETRATION EFFECTS IN THE INTERNAL CONVERSION OF 350 kev γ RAYS OF ^{207}Tl. Gorodetzky, S.; Beck, F.; Knipper, A. (Institut de Recherches Nucleaires, Strasbourg). Nucl. Phys., 82: 275-88(1966). (In French).

The 350 kev l-forbidden transition in ^{207}Tl was studied. The mixing ratio $\delta_\gamma(E2/M1) = +0.271 \pm 0.004$ was deduced from a measurement of the plane polarization of the γ rays; the mixture of the preceding α transition (L = 3 + 5) was also determined. The K-shell internal conversion coefficient was measured, $\alpha_K = 0.2041 \pm 0.0037$. The knowledge of the mixing ratio and the conversion coefficient was used to study the penetration effects in the internal conversion, giving two possible values, $\lambda \approx 1$ and $\lambda \approx 74$ for the penetration factor defined by Church and Weneser. The analysis of an additional angular correlation experiment, between α rays and K-shell conversion electrons, yielding $A_2 = -0.010 \pm 0.015$, rules out unambiguously the larger value of λ. (auth)

28366 INVESTIGATION OF THE LEVELS OF ^{131}Xe. Moss, G. A.; Wells, D. O.; McDaniels, D. K. (Univ. of Oregon, Eugene). Nucl. Phys., 82: 289-95(1966).

The gamma spectrum from the decay of ^{131}I was reinvestigated using a 3-mm depletion depth lithium-drifted germanium detector. Gamma rays of the following energies and relative intensities were observed in ^{131}Xe: 80.166(1.0), 177.02(0.101), 284.31(2.394), 325.68(0.090), 364.47(32.28), 502.75(0.146), 636.30(2.931) and 722.92(0.663) kev. A directional correlation measurement of the 80.166−284.31 kev cascade was performed using a lithium-drifted germanium detector coupled with a gain stabilized NaI(Tl) spectrometer and the spin of the first excited state is shown to be ½. (auth)

28367 INVESTIGATION OF VARIOUS APPROXIMATIONS IN THE CALCULATION OF VIBRATIONAL MODES OF ^{16}O AND ^{40}Ca. Stamp, A. P. (Nuclear Physics Lab., Oxford); Mayers, D. F. Nucl. Phys., 82: 296-307(1966).

The effect of a finite range, two-body force is studied. A comparison is made of the matrix elements calculated using harmonic oscillator and Woods-Saxon wave functions. (auth)

28368 EVEN PARITY STATES IN ^{16}O. Seaborn, J. B.; Eisenberg, J. M. (Univ. of Virginia, Charlottesville). Nucl. Phys., 82: 308-20(1966).

Procedures are established for constructing and eliminating spurious shell model states in the jj-coupling scheme for double closed shell nuclei. The program is applied to even parity states in ^{16}O with spin and isospin values $J^\pi(T) = 0^+(0,1), 1^+(0), 2^+(0), 4^+(0,1)$. Energy eigenvalues and eigenvectors and photo- and electro-excitation transition matrix elements are calculated using a zero-range residual interaction. All relevant two-particle/two-hole excitations are included. The results are compared with the available experimental data below 20 Mev. The spectrum of $0^+(0)$ and $2^+(0)$ states agrees reasonably well with the observed levels, but the energies of the $4^+(0)$ levels are much too low. Form factors for inelastic electron scattering are generally much smaller than the measured values. This is also true for the pair emission rate of the lowest 0^+ level. The admixture of the closed shell configuration into the 0^+ excited states is also considered. (auth)

28369 CALCULATION OF EVEN-PARITY STATES IN ^{16}O. Borysowicz, Jerzy (Univ. of Copenhagen). Nucl. Phys., 82: 321-30(1966).

Energies and wave functions for even-parity states in ^{16}O are calculated using the simplest available shell-model configurations. A method given by Brink and Nash is developed and some simplification in comparison with standard shell-model calculations is obtained. Results and their discussion are given. (auth)

28370 ^{149}Sm(n,α)^{146}Nd REACTION WITH LOW ENERGY NEUTRONS. Poortmans, F.; Ceulemans, H.; Deruytter, A. J.; De Mevergnies, M. Neve (SCK-CEN, Mol, Belg.). Nucl. Phys., 82: 331-6(1966).

The α spectrum from the ^{149}Sm(n,α)^{146}Nd reaction with slow neutrons was measured for three different incident neutron energies. The results confirm that the spin of the 0.0976 ev resonance of ^{149}Sm is 4 and show the existence of a negative energy resonance with spin 3. (auth)

28371 STRUCTURE OF THE SHELL-MODEL WAVE FUNCTIONS OF ^{22}Na AND ^{22}Ne. Tewari, S. N.; Banerjee, M. K. (Saha Inst. of Nuclear Physics, Calcutta). Nucl. Phys., 82: 337-53(1966).

The structure of the shell-model wave functions for the T = 0 and J = 3, 4, and 5 states of ^{22}Na and the T = 1 and J = 0, 2 and 4 states of ^{22}Ne was studied to test the existence of an intrinsic wave function. The SU_3 representation is very convenient for the purpose and was employed. Good intrinsic wave functions are found for both nuclei. There is a slight J-dependence in the case of ^{22}Na. The intrinsic wave function of ^{22}Na is almost purely a single determinant and it compares well with the Hartree-Fock solution. An attempt is made to explain the J-dependence on the basis of the theory of Peierls and Thouless. The intrinsic wave function of ^{22}Ne shows considerable two-particle correlation. The amount of this correlation is of the same order as that of the pairing correlation predicted by a self-consistent Hartree-Fock-Bogolyubov calculation. An explanation of the observed difference in the character of the two intrinsic wave functions is suggested. The interaction employed in this calculation is close to a Serber exchange, Yukawa potential with the usual spin dependence. It cannot be regarded as a very satisfactory choice. Thus no attempt is made to compare the level spacings. However the level ordering is found to be satisfactory. (auth)

28372 INTERPOLATING FORMULAE FOR DIRECT NUCLEAR REACTIONS. I. Dar, A. (Weizmann Inst. of Science, Rehovoth, Israel). Nucl. Phys., 82: 354-71 (1966).

Direct nuclear reactions at medium energies are discussed in a simple semi-classical approximation. Nuclear distortions are taken into account by a finite range diffraction model. Coulomb effects are included and a smooth cut-off for the nuclear absorption is introduced. Simple analytical expressions are derived for the angular distribution of the reaction products. Predictions of previous diffraction models are shown to be special cases of the present formulas. (auth)

28373 LOW-ENERGY LEVEL SCHEME OF ^{46}Sc DEDUCED FROM THE ^{45}Sc(n,γ)^{46}Sc CAPTURE GAMMA RAYS. Van Assche, P.; Gruber, U.; Maier, B. P.; Koch, H. R.; Schult, O. W. B. (Technical Univ., Munich. Research Establishment, Riso, Denmark). Nucl. Phys., 82: 373-84 (1966).

The thermal neutron capture gamma-ray spectrum of the reaction ^{45}Sc(n,γ)^{46}Sc was measured with the Risø bent crystal gamma spectrometer. Some 27 gamma transitions out of a total of 53, representing nearly 95% of the sum of the measured intensities, were fitted in the level scheme. For most levels, spin and parity assignments are proposed and discussed on the basis of the experimental results. (auth)

28374 CALCULATION OF OFF-SHELL SCATTERING AMPLITUDES. Nishida, Yoshihiko (Saga Univ., Japan). Nucl. Phys., 82: 385-400(1966).

The off-shell amplitudes for nucleon-nucleon scattering are calculated for nucleon scattering from complex nuclei, under the assumption that the two-nucleon interaction is given by a spin-dependent Gaussian potential with Serber exchange character. It is shown that the approximation method previously proposed by the writer and collaborators in connection with other problems is applicable also to this case, in spite of the fact that the conditions are rather different here. While the present approach assumes an artificial potential between two nucleons, this has the advantage

that the off-shell amplitudes can be written in closed form and the accuracy of the method can be insensitive to the energy difference between the initial and final states. It is confirmed by numerical investigations that the present approach enables one to obtain the off-shell amplitudes with remarkable accuracy for a very wide range of initial and final energies, as well as for all scattering angles. Finally, the accuracy of the conventional procedure which consists in replacing the off-shell amplitudes by the on-shell ones with the same momentum transfer is examined. It is shown that in such a replacement the use of the initial on-shell amplitudes is much more accurate than that of the final on-shell ones, and the former approximation has a fair success in predicting the off-shell amplitudes for a wide range of angles in the forward scattering hemisphere and for a large region of incident energies. (auth)

28375 MULTIPOLARITY OF THE ISOMERIC TRANSITION IN ^{191}Os. Plajner, Z.; Brabec, V.; Dragoun, O. (Nuclear Research Inst., Rez, Czechoslovakia). Nucl. Phys., 82: 401-6(1966).

Conversion electrons of the isomeric transition in ^{191}Os were studied in a double focussing magnetic beta-ray spectrometer. A (0.5 ± 0.1)% E4 admixture in the 74.37 ± 0.02 kev M3 transition was derived from the internal conversion electron intensity ratios L_I: L_{II}: L_{III} = (51.0 ± 3.5) : (10.9 ± 0.8) : 100. The half-life of the isomeric state was determined to be $T_{½}$ = 13.03 ± 0.21 h. Further internal conversion electron intensity ratios were measured; M_I : M_{II} : M_{III} : M_{IV} + M_V : N + O : L_{III} = (17.8 ± 1.8) : (7.7 ± 0.6) : (33.0 ± 1.7) : (3.4 ± 0.3) : (17.6 ± 1.1) : 100. (auth)

28376 THEORY OF DIRECT TRANSFER NUCLEAR REACTIONS. El-Batanoni, F.; El-Nadi, M.; Vysotsky, G. L. (Atomic Research Centre, Cairo). Nucl. Phys., 82: 407-16(1966).

When in direct reactions a group of transferred nucleons in the projectile or in the residual nucleus is described by the shell model, the expansion of the shell-model wave functions into cluster wave functions leads to mixture of the orbital and total momenta of the transferred cluster. The cluster reduced widths for such reactions differ from those resonance reactions, as the group may not be transferred in its ground state. Reduced widths, calculated by the plane wave theory of direct transfer reactions, permit a straightforward comparison with experimental data. (auth)

28377 DOUBLE TRANSFER PROCESSES IN DIRECT INTERACTIONS. El-Nadi, M.; Rihan, T. H.; Zohni, O. (Atomic Energy Establishment, Cairo). Nucl. Phys., 82: 417-26(1966).

The reactions between complex nuclei, in which transfer of two different particles leads to the same pair of product nuclei, are investigated on the basis of the direct interaction mechanism. Assuming the cluster-model picture, the resulting theoretical formulas obtained in the plane wave Born approximation are compared with some experimental data. Good agreement is obtained. (auth)

28378 POLARIZATION AND ANGULAR CORRELATION IN PICKUP REACTIONS. Abul-Magd, A. Y. (Atomic Energy Establishment, Cairo). Nucl. Phys., 82: 427-32(1966).

Polarization phenomena in pickup reactions are investigated for the reaction produced by polarized incident beams and oriented target nuclei. Formulas are obtained for the polarization of emitted particles and the angular correlation of any ensuing radiation with these particles. (auth)

28379 INTERNAL CONVERSION COEFFICIENTS FOR M4 TRANSITION IN Te. Bhalla, C. P. (Univ. of Alabama, Huntsville). Nucl. Phys., 82: 433-40(1966).

Theoretical results of β_4 for the subshells including M-subshells are presented in the 81.78 kev transition of ^{121m}Te. Numerical results for gamma energy equal to 0.15 mc^2 are also presented and compared with the earlier calculations of Rose and of Sliv and Band. Atomic screening and the finite nuclear size effects are included accurately. The experimental data of Chu and Perlman compare favorably with the new theoretical results. The calculated eigenvalues are also found to be in reasonable agreement with the experimental binding energies. (auth)

28380 MEASURED LIFETIMES OF THE 8.4, 118, AND 139 kev NUCLEAR LEVELS IN ^{169}Tm AND OF THE 396 kev LEVEL IN ^{175}Lu. McAdams, R. E.; Eakins, G. W.; Hatch, E. N. (Ames Lab., Ames, Iowa). Nucl. Phys., 82: 449-70(1966). (IS-1217).

The half-lives of the 8.4, 118, and 139 kev levels in ^{169}Tm were measured using fast coincidence techniques in conjunction with two magnetic intermediate-image beta-ray spectrometers placed back-to-back. Major emphasis was placed upon determining the lifetime of the 8.4 kev level. Both ^{169}Er and ^{169}Yb decays were used in measuring the half-life of this level, and acceleration voltages up to −27 kv were applied to the radioactive sources. The half-life of the 8.4 kev level was found to be 4.13 ± 0.12 nsec. The half-lives of the 118 and 139 kev levels in ^{169}Tm were measured using the ^{169}Yb decay and were found to be 63 ± 7 psec and 289 ± 24 psec, respectively, in agreement with previous measurements. From the experimental lifetimes of the first three excited levels in the ^{169}Tm ground-state rotational band, the parameters $|G_0|$ and b_0, as defined by Nilsson, were evaluated to be $|G_0|$ = 1.90 ± 0.16 and b_0 = −(0.17 ± 0.04). These results are in good agreement with the values given for these parameters from other experiments. The half-life of the 396 kev level in ^{175}Lu was also measured as a check on the experimental equipment and method and was found to be 3.31 ± 0.10 nsec, which is in good agreement with other reported values. (auth)

28381 DECAY OF ^{106}In. Catura, R. C.; Richardson, J. Reginald (Univ. of California, Los Angeles). Contract NONR-233(44). Nucl. Phys., 82: 471-80(1966).

The half life for decay of ^{106}In was measured to be 5.3 ± 0.1 min. A magnetic lens spectrometer was used to investigate the positron spectrum of this isotope. Two positron components were found whose transition energies are 4.89 ± 0.03 and 2.7 ± 0.1 Mev. Seven gamma rays involved in the decay of ^{106}In were resolved at energies of 0.53, 0.63, 0.86, 0.99, 1.66, 1.88 and 2.2 Mev. Beta-gamma coincidence measurements indicate the highest energy positron component to be coincident with only the 0.63 Mev gamma ray. In addition, the 2.7 Mev positron transition is coincident with gamma rays at 0.63, 0.86, 0.99, 1.66 and 1.88 Mev. The gamma rays at 0.63, 0.86, and 0.99 Mev were measured to be in coincidence. A search was made for the presence of an isomeric state in the decay of ^{106}In with a half life in the range from 0.5 sec to several hours. The investigation produced no evidence for the existence of such a state. (auth)

28382 BETA-SPECTRUM SHAPE MEASUREMENTS WITH A 4π SEMICONDUCTOR SPECTROMETER. Spejewski, E. H. (Indiana Univ., Bloomington). Nucl. Phys., 82: 481-8(1966).

A 4π semiconductor spectrometer employing diffused window lithium-drifted silicon detectors was constructed. It was tested by varying the parameters of the system, so as to eliminate possible sources of distortion. It was further tested by measuring the shapes of two simple β-spectra (^{143}Pr and ^{185}W) and two inner group β-spectra (^{198}Au and ^{86}Rb) in coincidence with the subsequently emitted γ-rays. The γ-ray pulse, detected by a NaI well counter that envelops the beta spectrometer, supplied the gate to the 400-channel pulse-height analyzer. In all cases, the results of these measurements are in good agreement with those previously reported. The beta spectrum of the ^{170}Tm decay to the first excited level in ^{170}Yb was measured in coincidence with the 84 kev gamma ray. The experiment was performed under the same measurement conditions used for the ^{198}Au and ^{86}Rb experiments. The spectrum exhibits a definite non-statistical energy dependence, falling below any straight line Fermi-Kurie plot fit at low energies. The shape factor was fitted by a polynomial of the form 1 + aW + b/W + cW^2. A good fit was obtained for a = 1.11, b = 0.85, c = −0.24. The end-point of this transition was determined to be 879 ± 7 kev. (auth)

28383 REACTIONS INDUCED IN ^{40}Ca BY 150-Mev PROTONS. Newton, D.; Salmon, G. L.; Clegg, A. B. (Oxford Univ.). Nucl. Phys., 82: 499-512(1966).

The low-lying states produced in residual nuclei from reactions induced by bombarding ^{40}Ca with 150 Mev protons were studied in two sets of measurements: (i) gamma radiation was studied in coincidence with a single proton of selected energies, and (ii) gamma radiation was studied in coincidence with at least two outgoing protons. Information was obtained in particular about the mechanisms of the ^{40}Ca(p,2p) and (p,pα) reactions and about the structures of the residual nuclei ^{39}K, ^{38}Ar and ^{36}Ar. (auth)

28384 ^{39}K(p,2p) REACTION AT 150 Mev. Newton, D.; Salmon, G. L.; Clegg, A. B. (Oxford Univ.). Nucl. Phys., 82: 513-20(1966).

The low-lying states of ^{38}Ar, which are produced in the ^{39}K(p,2p) reaction induced by 150 Mev protons, were found by studying gamma radiation in coincidence with two outgoing protons. The results are compared with the two-hole states expected in an intermediate coupling model. These results suggest that, though there are many more states of ^{38}Ar than would be expected solely from two holes in ^{40}Ca, the two-hole states are contained in a very few of the actual states. The second excited state of the "rotational band" based on the ground state is tentatively identified at 6.6 Mev, an energy which is 3.0 times the energy of the first excited state. The results are compared with measurements of the ^{40}Ca(p,3p) reaction, providing information about the mechanism of this reaction and further information about the structure of ^{38}Ar. (auth)

28385 EFFECT OF THE CONTINUUM ON THE SINGLE-PARTICLE DESCRIPTION OF THE GIANT E1 RESONANCE. Diehl, B. (Lund Inst. of Tech., Sweden). Nucl. Phys., 82: 521-32(1966).

A numerical calculation of the E1 absorption cross section for an oxygen-like nucleus was performed for the case of noninteracting particles in a Woods-Saxon potential with spin-orbit coupling. The Thomas-Kuhn-Reiche sum rule is found to be exhausted to 99.5% already at an energy of 30 Mev. The energy distribution was investigated by means of sum rules. A comparison between the results obtained from a Woods-Saxon potential and those obtained from a harmonic oscillator potential shows only small differences. (auth)

28386 THREE-BODY WAVE FUNCTION FOR (d,p) REACTIONS. Pearson, C. A. (Australian Atomic Energy Commission, Sutherland. Univ. of Copenhagen); Coz, M. Nucl. Phys., 82: 533-44(1966).

A new theory of (d,p) stripping reactions is proposed, which is based on a three-body wave function for describing the deuteron-target nucleus scattering. As a starting point for generating this wave function it is assumed that when the deuteron reaches the target nucleus the proton is freed from its partner neutron and is scattered from the short-range part of the proton-target nucleus interaction as if the neutron were not present. It is suggested that this assumption about the proton wave function can be tested directly by comparing with experiment. Experimental evidence is presented, which supports the chosen proton wave function. (auth)

28387 EXPERIMENTAL EVIDENCE FOR A (d,p) STRIPPING MODEL. Pearson, C. A. (Australian Atomic Energy Commission, Lucas Heights. Univ. of Copenhagen); Coz, M. Nucl. Phys., 82: 545-60(1966).

The experimental data that reveal the central role played by the proton-target nucleus elastic scattering in the (d,p) stripping reaction are presented. This justifies the description of the stripping process. The data used are the experimental angular distributions and polarization from (d,p) reactions with l = 0. It is shown that the detailed features of the angular distributions, and polarization for these reactions, are determined by the elastic scattering of the protons from the short-range part of the proton-target nucleus interaction. (auth)

28388 HIGH-ENERGY TRANSITIONS IN ^{182}W FOLLOWING THE DECAY OF ^{182}Ta. Korkman, K.; Baecklin, A. (Uppsala Univ.). Nucl. Phys., 82: 561-73(1966).

The internal conversion spectrum above 800 kev was measured with a double focussing spectrometer. Of the 19 transitions observed, 18 could be fitted into the level scheme. The energies of the strongest lines were determined with an accuracy of 0.1 kev. With a Ge(Li) detector, gamma-ray intensities were measured for 14 transitions. The level scheme is discussed in terms of the rotation-vibration interaction model of Faessler et al. (auth)

28389 SPIN ASSIGNMENTS IN ^{33}S FROM THE REACTION ^{32}S(d,p)^{33}S. O'Dell, J. M.; Krone, R. W.; Prosser, F. W. Jr. (Univ. of Kansas, Lawrence). Nucl. Phys., 82: 574-92(1966).

The gamma rays emitted in the decay of several of the low-lying states of ^{33}S were observed in coincidence with the proton groups populating these states in the reaction ^{32}S(d,p)^{33}S. Angular correlations obtained between the protons, detected at 0^0 with respect to the incident beam, and the gamma rays were analyzed by the method of Litherland and Ferguson to determine the spins and population parameters of the 1.965, 2.313, 2.937 and 3.224 Mev states of ^{33}S, as well as the multipole mixing ratios and branching ratios of the gamma-ray transitions. The following results were obtained using a deuteron bombardment energy E_d = 2.541 Mev. The 3.224 Mev state has spin $^3/_2$ and decays to the ground state and the first excited state. The 2.937 Mev state has spin $^7/_2$ and decays with equal intensities to the ground state and the 1.965 Mev state. The 2.313 Mev state has a probable spin $^3/_2$ and decays to the ground state and the first excited state. The 1.965 Mev state has spin $^5/_2$ and decays only to the ground state. There is some evidence for the presence of a state at 1.35 Mev, which may be the $^5/_2^+$ state predicted at 1.38 Mev. It appears to decay by a two step transition with γ-ray energies of 0.51 and 0.84 Mev; this, together with the weakness of the proton group, causes the identification to remain tentative at present. (auth)

28390 ^{186}Os SPECTRUM FOR AN ASYMMETRIC NUCLEI OR ROTATION-VIBRATION INTERACTION. Lindner, Albrecht (Univ., Frankfurt am Main). Nucl. Phys., 82: 593-610(1966). (In German).

In the gamma band of ^{186}Os the levels of even spin are shifted downwards with respect to the levels of odd spin. It is shown that the asymmetric rotator model would predict this effect in the opposite direction. The interaction of rotations and harmonic quadrupole vibrations about a deformed but axial-symmetric equilibrium is studied up to second order. Here the odd-even effect is in the right direction for $E_\beta > E_\gamma$, but the spectrum cannot be fitted here either. (auth)

28391 POSITRON BETA DECAY OF NEUTRON-DEFICIENT ISOTOPES. Goldanskii, V. I. (Inst. of Chemical Physics, Moscow). Nucl. Phys., 82: 611-13(1966).

The isotopic invariance principle leads to the following simple restrictions for energies of positron beta-decay: for $Z \geqq N + 1$, $Q_{\beta^+} \geqq 0.95(Z-1)^{4/3} - 0.78$ Mev; for $Z < N + 1$, $Q_{\beta^+} \leqq 0.95(Z-1)^{4/3} - 0.78$ Mev. The difference $Q^0_{\beta^+} = 0.95(Z-1)^{4/3} - 0.78$ Mev describes the energy of superallowed β^+ decay (without change of the isospin) characteristic of all nuclei with $Z \geqq N + 1$, but of only few nuclei with $Z < N + 1$ (in the case of inversion of levels with different isospins). Many widely used tables of atomic nuclei masses do not allow for the above mentioned restrictions. (auth)

28392 LEVELS IN THE ODD NUCLEUS ^{156}Eu. Hansen, P. G.; Nielsen, H. L.; Williams, E. T.; Wilsky, K. (Research Establishment Risoe, Roskilde, Denmark). Nucl. Phys., 82: 614-24(1966).

The decay of 9.4 h ^{156}Sm produced in fractional μC amounts by the thermal-neutron fission of ^{239}Pu was studied by electron and gamma-ray spectrometry and by e-γ, β-γ, and e-β coincidence techniques. Levels characterized by the quantum numbers (K,I$^\pi$) were established at the following energies in kev: 0 (0,0$^+$), 22.6 (0,1$^+$), 47.9 (0,2$^+$) (tenta-

tive), 87.6 (1,1⁻), 125.7 (1,2⁻), 291.4 (1,1⁺). These levels are interpreted as corresponding to the three intrinsic configurations $\{5/2^+[413] - 5/2^+[642]\}_{0^+}$, $\{5/2^+[413] - 3/2^-[521]\}_{1^-}$ and $\{1/2^-[523] - 5/2^-[523]\}_{1^+}$. (auth)

28393 PHENOMENOLOGICAL MODEL OF ALPHA-^{12}C ELASTIC SCATTERING. Ceuleneer, R.; Demeur, M.; Reignier, J. (Univ., Libre, Brussels). Nucl. Phys., 82: 625-34(1966). (In French).

Some experimental data concerning the backward α-^{12}C elastic scattering around 20 Mev are analyzed on the basis of a "one Regge pole" model. This model gives a rather satisfactory representation of the main characteristics of the phenomenon and it appears possible to make definite predictions concerning the resonant α-^{12}C system. The experimental data needed in order to investigate the model from a more quantitative viewpoint are also indicated. (auth)

28394 NEUTRON POLARIZATION FOR ^{11}B(d,n)^{12}C$_{g.s.}$ AND ^{11}B(d,n)^{12}C$_{4.43}$ AT 1.45 Mev. Mason, G. R.; Sample, J. T. (Univ. of Alberta, Edmonton). Nucl. Phys., 82: 635-44(1966).

A neutron polarimeter utilizing helium gas proportional counters was used to measure the angular distribution of neutron polarization for the reactions ^{11}B(d,n)^{12}C$_{g.s.}$ and ^{11}B(d,n)^{12}C$_{4.43}$ at a mean deuteron energy of 1.45 Mev. Polarizations for both neutron groups were found generally to be small (less than 30%) and positive (using the Basel convention). Angular distributions of the products of polarization values and differential cross sections are fitted with associated Legendre functions. (auth)

28395 LONGITUDINAL POLARIZATION OF BACK-SCATTERED NEGATONS. Braicovich, L.; De Michelis, B.; Fasana, A. (Istituto di Fisica del Politecnico, Milan). Nucl. Phys., 82: 645-51(1966).

The average longitudinal polarization of β particles of ^{90}Sr + ^{90}Y, backscattered by targets of different atomic number, was measured with a Moeller analyzer, in the energy range 0.3–2.0 Mev. The longitudinal polarization decreases with the atomic number and within the experimental errors vanishes, when a lead backscatter is employed; the results are not affected by instrumental effects to an extent greater than ±5%. The results are discussed with reference to the mechanism of the backscattering process. (auth)

28396 TOTAL NEUTRON CROSS SECTIONS OF Cu, Fe, Mg, AND Al NEAR 14 Mev. Albergotti, J. C.; Ferguson, J. M. (Naval Radiological Defense Lab., San Francisco). Nucl. Phys., 82: 652-6(1966).

Total neutron cross sections of Mg, Al, Fe, and Cu were measured using T(d,n) neutrons in the energy range 12 to 14 Mev. The accuracy (counting statistics) is better than 1%. The energy resolution (two standard deviations of the energy resolution function) varies from 35 to 150 kev. Fluctuations of amplitude 2 to 3% and width of the order of 100 kev are found in the cross sections of Mg and Al. No such variations are found in the cross sections of Fe and Cu; a χ^2 test agrees with a straight line fit to the Fe and Cu data. (auth)

28397 INTERACTIONS OF 13.8 Gev/c PROTONS WITH HEAVY NUCLEI IN EMULSION EXPOSED IN A STRONG MAGNETIC FIELD. Gil, D.; Gomez, J. L.; Tarrega, P.; Villar, E. (Facultad de Ciencias, Valencia). Nucl. Phys., 82: 662-772(1966).

A total of 145 stars with $N_h > 8$ produced by the interaction of 13.8 Bev/c protons with Ag and Br nuclei were analyzed. The emulsion stack was irradiated in a 170 kG magnetic field. Statistical results concerning the main characteristics of the different particles emitted are given and the energy balance is evaluated. The main features of both 24 Bev/c protons and 17 Bev/c π^- interactions are compared with those found for 13.8 Bev/c proton interactions. (auth)

28398 POSSIBLE INDICATION OF THE SPIN-FLIP GIANT RESONANCE IN THE REACTION ^{89}Y(p,γ_0)^{90}Zr. Obst, E.; Rauch, F.; Roessle, E. (Johann Wolfgang Goethe-Univ., Frankfurt am Main). Phys. Lett., 21: 50-1(Apr. 15, 1966).

Details of the giant resonance are studied by measuring the excitation function of the reaction ^{89}Y(p,γ_0)^{90}Zr for protons at 2.2 to 6.3 Mev in 40 kev steps. (B.G.D.)

28399 STRUCTURE OF THE THREE-PARTICLE NUCLEI FROM PHOTODISINTEGRATION EXPERIMENTS. Fetisov, V. N. (Lebedev Inst. of Phys., Moscow). Phys. Lett., 21: 52-4(Apr. 15, 1966).

The role of the asymptotic structure of three-particle nuclei in the description of the photoeffect is discussed. A sharp decrease of the total cross sections of the reactions $\gamma + {}^3\text{He}({}^3\text{He}) \rightarrow 2p(2n) + n(p)$ is obtained in comparison with the previous calculations. (auth)

28400 EFFECTIVE INTERACTIONS, ENERGIES AND SENIORITIES IN THE SPECTRA OF THE NICKEL ISOTOPES. Auerbach, N. (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Lett., 21: 57-60(Apr. 15, 1966).

The spectra of ^{58}Ni, ^{59}Ni, ^{60}Ni, and ^{64}Ni are calculated without the restriction to states of lowest seniority. (auth)

28401 NEW LIST OF RECOMMENDED ACCELERATOR CALIBRATION ENERGIES. Marion, J. B. (California Inst. of Tech., Pasadena). Phys. Lett., 21: 61-2(Apr. 15, 1966).

A new analysis of precision, absolute nuclear reaction energy measurements has been made and recommended values (weighted means) are given for 13 proton-induced resonances and thresholds. (auth)

28402 SHELL MODEL CALCULATIONS ON ^{54}Cr, ^{56}Fe, AND ^{57}Fe. McGrory, J. B. (Oak Ridge National Lab., Tenn.). Phys. Lett., 21: 64-6(Apr. 15, 1966). (ORNL-P-2046).

A shell model calculation of the energy levels of ^{54}Cr, ^{56}Fe, and ^{57}Fe is reported. Protons in the 1f 7/2 orbit and neutrons in the 2p 3/2, 2p 1/2, and 1f 5/2 orbits are treated as active particles. Good agreement with experiment is found for all three nuclei. (auth)

28403 STUDY OF THE (n,d) REACTION AT 152 Mev. Measday, D. F. (Harvard Univ., Cambridge, Mass.). Phys. Lett., 21: 62-3(Apr. 15, 1966).

Proton pickup by 152-Mev neutrons was observed in ^{4}He, ^{6}Li, ^{7}Li, and ^{12}C. Because an energy resolution of 10 Mev was achieved, the pickup from different shells was separated. (auth)

28404 ^{2}H(n,p)2n REACTION AT 152 Mev. Measday, D. F. (Harvard Univ., Cambridge, Mass.). Phys. Lett., 21: 66-8(Apr. 15, 1966).

The ^{2}H(n,p)2n reaction was studied using a 152-Mev monokinetic neutron beam. The cross section and the width of the proton peak were measured in the laboratory angle range 0 to 30°. (auth)

28405 MONOPOLE MATRIX ELEMENT OF THE ^{16}O 6.06 Mev LEVEL. Boeker, E. (Oxford Univ.). Phys. Lett., 21: 69-70(Apr. 15, 1966).

The 6.06-Mev level of ^{16}O and the ground state are described as a linear combination of 0p0h, 2p2h, and 4p4h states. The influence of the deformation of these states on the monopole matrix element is investigated. For Brown and Green's parameters a value of 2.6 fm^2 is found. (auth)

28406 MONOPOLE MATRIX ELEMENT IN ^{16}O. Bertsch, G. F. (Niels Bohr Inst., Copenhagen). Phys. Lett., 21: 70-2(Apr. 15, 1966).

The strong hindrance of 2γ decay in the monopole decay of ^{16}O is explained with the wave functions of Brown and Green. (auth)

28407 ASYMMETRY IN ELASTIC AND INELASTIC SCATTERING OF POLARIZED PROTONS FROM ^{48}Ti, ^{50}Ti, ^{54}Fe, AND ^{56}Fe. Garin, A.; Glashausser, C.; Papineau, A.; De Swiniarski, R.; Thirion, J. (CEN, Saclay, France). Phys. Lett., 21: 73-5(Apr. 15, 1966).

The asymmetry in the elastic and inelastic scatterings of 18.6-Mev polarized protons was measured for targets of ^{48}Ti, ^{50}Ti, ^{54}Fe, and ^{56}Fe. The results for the first 2^+ states in ^{48}Ti, ^{56}Fe, and the second 2^+ in ^{54}Fe are similar

to each other and to previous data for Ni; the first 2^+ state in ^{54}Fe shows much larger asymmetries, resembling the 2^+ in ^{50}Ti. (auth)

28408 ELASTIC AND INELASTIC SCATTERING OF 14.71 Mev PROTONS BY ^{89}Y. Awaya, Y. (Inst. of Physical and Chemical Research, Tokyo). Phys. Lett., 21: 75-7(Apr. 15, 1966).

The elastic and inelastic scattering of 14.71-Mev protons by ^{89}Y was investigated by using a broad range magnetic spectrometer with a solid state detector array. Angular distributions corresponding to the ground and thirteen excited states of ^{89}Y were obtained. (auth)

28409 SPIN OF A BROAD STATE AROUND 10 Mev IN ^{12}C. Morinaga, H. (Brookhaven National Lab., Upton, N. Y.). Phys. Lett., 21: 78-9(Apr. 15, 1966). (BNL-10027).

The assignment of 2^+ to a broad structure around 10 Mev in ^{12}C is made plausible. This state could be part of a deformed band. (auth)

28410 COULOMB ENERGY DIFFERENCES IN THE 1p-SHELL. Wilkinson, D. H.; Hay, W. D. (Oxford Univ.). Phys. Lett., 21: 80-1(Apr. 15, 1966).

Coulomb energy differences are computed for nuclei of the 1p-shell using wavefunctions in potentials that fit electron scattering and (p,2p) data. These energy differences are in good agreement with the corresponding binding energy differences. (auth)

28411 INVERSE GAP EQUATION AND PHENOMENOLOGICAL APPROACH TO NUCLEAR STRUCTURE. Gillet, V.; Rho, M. (CEN, Saclay, France). Phys. Lett., 21: 82-4(Apr. 15, 1966).

A phenomenological approach to finite degenerate nuclei is proposed whereby the Bardeen-Cooper-Schrieffer wave function as well as the force strength are determined from observed spectra. The method is free of the ambiguities associated with the unknown Hartree-Fock energies. (auth)

28412 CONNECTION BETWEEN THE SURFACE DELTA INTERACTION AND THE PAIRING PLUS QUADRUPOLE MODEL IN SPHERICAL NUCLEI. Touchard, J. (Institut de Physique Nucleaire, Orsay, France). Phys. Lett., 21: 85-6(Apr. 15, 1966).

It is shown that the surface delta interaction in single closed shell spherical nuclei leads to a description which is very similar to the usual pairing plus quadrupole model if the recoupling terms are ignored. (auth)

28413 PROTON CORE EXCITATION IN THE GROUND STATE OF ^{18}O. Rost, E. (Princeton Univ., N. J.). Phys. Lett., 21: 87-90(Apr. 15, 1966).

A distorted wave analysis of the ^{18}O(^{3}He,d)^{19}F reaction using deformed-well radial wave functions yields rather large core-excitation admixtures in the ground state of ^{18}O. (auth)

28414 RADIATIVE π^- CAPTURE IN NUCLEI. Delorme, J. (Univ., Lyon); Ericson, T. E. O. Phys. Lett., 21: 98-100(Apr. 15, 1966).

An effective hamiltonian for the process $\pi^- + N(A,Z) \rightarrow N^*(A,Z-1) + \gamma$ is derived from pion photoproduction in the impulse approximation. Good agreement with total experimental yields is found using techniques from the theory of μ^- capture in nuclei. (auth)

28415 HIGH-PRECISION MEASUREMENTS OF THE g_J FACTORS OF THE ALKALIS USING THE ATOMIC BEAM MAGNETIC RESONANCE METHOD. Boeklen, K. D. (Univ., Heidelberg); Dankwort, W.; Pitz, E.; Penselin, S. Phys. Lett., 21: 294-5(May 15, 1966).

The g_J-factors of ^{6}Li, ^{7}Li, ^{23}Na, ^{85}Rb, ^{87}Rb and ^{133}Cs in their $^2S_{\frac{1}{2}}$ ground states have been measured relative to the g_J-factor of ^{39}K with a precision of a few parts in 10^7 using the atomic beam magnetic resonance method. (auth)

28416 CONCEALED CONFIGURATION MIXING AND THE SPECTROSCOPY OF THE PSEUDONIUM NUCLEI. Cohen, S. (Argonne National Lab., Ill.); Lawson, R. D.; Soper, J. M. Phys. Lett., 21: 306-9(May 15, 1966).

The calculation shows that many nuclear properties are extremely insensitive to configuration mixing arising from the excitation of zero-coupled pairs out of a closed shell. (auth)

28417 EQUILIBRIUM DEFORMATIONS OF EXCITED STATES OF HEAVY NUCLEI. Soloviev, V. G. (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Lett., 21: 311-12(May 15, 1966).

The question as to whether there exist excited states with equilibrium deformation different from that of the ground state of the corresponding even nuclei, is investigated. Some examples of such states in nuclei lying outside the transition region are given. (auth)

28418 26-Mev STATE OF ^{13}N. Barker, F. C.; Patterson, J. R.; Poate, J. M.; Titterton, E. W. (Australian National Univ., Canberra). Phys. Lett., 21: 318-19(May 15, 1966).

From a measurement of the ^{10}B(^{3}He,p$\gamma_{15.11}$)^{12}C cross section between 4.5 and 9 Mev bombarding energy, it is argued that the ^{10}B + ^{3}He reactions do not excite an E1 giant resonance state in ^{13}N. (auth)

28419 ROLE OF INTERACTION OF QUASIPARTICLES WITH PHONONS IN ODD-ODD DEFORMED NUCLEI. Soloviev, V. G. (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Lett., 21: 320-2(May 15, 1966).

The effect of the interactions of quasiparticles with phonons on the structure of the ground and excited states of even mass deformed nuclei is investigated. It is shown that this interaction is rather important in the case of odd-odd nuclei and inessential in even-even nuclei. (auth)

28420 EFFECT OF COLLECTIVE VIBRATIONAL MOTION ON THE ANOMALOUS COUPLING STATES. Ikegami, H. (Tokyo Inst. of Tech.); Sano, M. Phys. Lett., 21: 323-6(May 15, 1966).

Evidence on the anomalous coupling $5/2^+$ and $7/2^+$ states which are unexpected from the previous theories, is presented. It is shown that the general features of the states are well predicted in the scheme of pairing plus quadrupole forces. (auth)

28421 ^{8}Be DETECTION AND THE ^{9}Be(^{7}Li,^{8}Li)^{8}Be REACTION. Lewis, C. W.; Blair, J. M. (Univ. of Minnesota, Minneapolis). Phys. Lett., 21: 326-8(May 15, 1966).

The alpha-alpha coincidence method of ^{8}Be detection has been used to obtain new data on the ^{9}Be(^{7}Li,^{8}Li)^{8}Be reaction. (auth)

28422 0^+ SPECTRA OF ^{48}Ca AND ^{50}Ca. Hinds, S. (Atomic Weapons Research Establishment, Aldermaston, Eng.); Bjerregaard, J. H.; Hansen, Ole; Nathan, O. Phys. Lett., 21: 328-30(May 15, 1966).

Data from (t,p) reactions on ^{46}Ca and ^{48}Ca are reported. New 0^+ states in ^{48}Ca and ^{50}Ca are identified. The character of these states is discussed. (auth)

28423 ODD-EVEN STAGGERING IN THE ISOTOPE SHIFT OF THE NUCLEAR RADIUS. Sorensen, R. A. (Niels Bohr Inst., Copenhagen). Phys. Lett., 21: 333-4 (May 15, 1966).

It is shown that spherical odd-mass nuclei are expected to have smaller mean square deformations than the neighboring even ones by an amount sufficient to explain the odd-even staggering of the isotope shift. (auth)

28424 ISOMERIC STATE IN ^{24}Al. Armini, A. J.; Sunier, J. W.; Polichar, R. M.; Richardson, J. R. (Univ. of California, Los Angeles). Phys. Lett., 21: 335-7 (May 15, 1966).

The existence of a 1^+ isomeric state is reported in ^{24}Al, with a half life of 129 ± 5 ms. The energies and intensities of the isomeric gamma transition and of three beta transitions have been measured. (auth)

28425 RANGES OF ^{126}Ba AND ^{128}Ba RECOIL FRAGMENTS IN ALUMINUM. Kaplan, Morton; Richards, John L. (Yale Univ., New Haven). Phys. Rev., 145: 153-7 (May 6, 1966).

Using thin-target, thin-catcher recoil techniques, the average ranges and range straggling of 97-min ^{126}Ba and

2.4-day ^{128}Ba in Al were measured. The Ba ions were produced with initial energies from 3 to 14 Mev by bombardment of ^{120}Sn, ^{121}Sb, and ^{123}Sb targets with ^{10}B, ^{11}B, ^{12}C, and ^{14}N ion beams. The assumption of a compound-nucleus mechanism in the nuclear reactions leads to a smooth relation between average range and recoil energy. Theoretical predictions are in good agreement with the observed ranges, but relatively small (<10%) systematic deviations become apparent at the higher energies. The range distributions are consistent with a Gaussian representation, and yield straggling parameters which are substantially larger than theoretical estimates of straggling inherent in the stopping process. Possible sources of the discrepancy are discussed. In one experiment, the product Ba ion is believed to be formed in a reaction involving emission of an alpha particle, and an abnormally large straggling parameter is observed. (auth)

28426 ft VALUES OF PURE FERMI BETA DECAYS AND THE MAGNITUDE OF THE VECTOR COUPLING CONSTANT. Freeman, J. M. (Atomic Energy Research Establishment, Harwell, Eng.); Jenkin, J. G.; Murray, G.; Burcham, W. E. Phys. Rev. Lett., 16: 959-62 (May 23, 1966).

Evidence is presented to show that there are significant variations among the ft values of pure Fermi beta decays indicating the possible existence of effects which could seriously influence the currently accepted value of the vector coupling constant G_B. (B.G.D.)

28427 DETECTION OF NUCLEAR MAGNETIC RESONANCE IN A 235-nsec NUCLEAR STATE BY PERTURBED ANGULAR CORRELATIONS. Matthias, E.; Shirley, D. A.; Klein, M. P.; Edelstein, N. (Univ. of California, Berkeley). Phys. Rev. Lett., 16: 974-6(May 30, 1966).

The resonant r-f absorption by 10^4 nuclei in the 74.8-kev excited state of ^{100}Rh is observed by combining nuclear magnetic resonance in a ferromagnet with perturbed angular correlations of the 84.0 – 74.8 kev γ ray cascade. (B.G.D.)

28428 COHERENT ELASTIC SCATTERING AND INCOHERENT INELASTIC SCATTERING IN PROTON-NUCLEUS COLLISIONS AT HIGH ENERGY. Dar, A.; Varma, S. (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Rev. Lett., 16: 1003-6(May 30, 1966).

A simple scattering model is presented in order to extract geometrical and dynamical information from the experimental data about the target nuclei in proton-nucleus collisions at high energies. The diffraction patterns are interpreted with the strong-absorption-model which takes into account both the shadow effects of elementary plus nuclear inelastic open channels and the effect of Coulomb interaction. The large-angle cross section for light nuclei is interpreted as a free proton-nucleus scattering operating between the projectile and a small fraction of the target nucleons. (B.G.D.)

28429 PARITY MIXING IN ^{180}Hf. Lawson, R. D.; Segel, R. E. (Argonne National Lab., Ill.). Phys. Rev. Lett., 16: 1006-8(May 30, 1966).

It is shown that the parity mixing that must be invoked in order to fit the conversion-coefficient data is inconsistent with the properties of the 501-kev crossover to the 6^+ state in ^{180}Hf and also that the selection rule that inhibits the emission of E1 radiation in the 57.6-kev transition must also affect the decay of the state by M1. (B.G.D.)

28430 NEUTRON EMISSION IN ^{226}Ra PROTON-INDUCED FISSION. Schmitt, H. W.; Konecny, E. (Oak Ridge National Lab., Tenn.). Phys. Rev. Lett., 16: 1008-11(May 30, 1966).

The average number of neutrons ν emitted as a function of m*, the prompt-fragment mass, was experimentally determined for 13-Mev proton induced fission of ^{226}Ra. The trend of ν (m*) is found to be similar to the familiar sawtooth shape observed in low-excitation fission. (B.G.D.)

28431 INVESTIGATION OF SOME MILLISECOND ISOMERS. Meyers, P.; Schats, J. J. C. (Instituut voor Kernphysisch Onderzoek, Amsterdam). Physica, 32: 179-84(Jan. 1966).

Millisecond isomers were produced by irradiation of several nuclides with 14 Mev neutrons. Gamma ray energies and half lives obtained from targets of Na, Mg, Al, Ge, As, Y, In, Pb and Bi are reported. (auth)

28432 ^{30}Si(p,γ)^{31}P REACTION FOR BOMBARDING ENERGIES BETWEEN 1.53 and 2.00 Mev. Van Rinsvelt, H. A.; Endt, P. M. (Rijksuniversiteit, Utrecht). Physica, 32: 513-28(Mar. 1966).

Eighteen resonances were observed in the ^{30}Si(p,γ)^{31}P reaction with protons in the energy region E_p = 1.53–2.00 Mev. The resonance energies, the resonance strengths, the excitation energies and the decay modes of the corresponding levels in ^{31}P are reported. The total widths of a few resonance levels as obtained from yield measurements with a very thin target are compared with the results of elastic proton scattering. The spin of all resonance levels was uniquely determined from γ-ray angular distribution and/or γ-γ angular correlation measurements. In some cases, a parity assignment was obtained from the evaluation of the M2 strength of the de-excitation radiation, the calculation of the reduced proton width, and/or the interpretation of recent ^{30}Si(p,p)^{30}Si work. (auth)

28433 DECAY SCHEME, SPIN AND PARITY OF THE 3.13, 3.29, 3.41 and 3.51 Mev LEVELS IN ^{31}P. Van Rinsvelt, H. A.; Endt, P. M. (Rijksuniversiteit, Utrecht). Physica, 32: 529-47(Mar. 1966).

Measurements of spectra, linear polarization, angular distributions and correlations of γ rays from the ^{30}Si(p,γ)^{31}P reaction at resonances below E_p = 2 Mev provided information on the decay scheme, spin and parity of the levels ^{31}P* = 3.13, 3.29, 3.41 and 3.51 Mev. The following branching percentages were observed in the decay: 3.13 Mev (γ_0 100%), 3.29 Mev (γ_1 82%, γ_2 18%), 3.41 Mev (γ_1 100%), 3.51 Mev (γ_0 70%, $\gamma_1 + \gamma_2$ 30%). The mixing parameters of the γ rays de-exciting these four levels were also determined. Spins and parities are as follows: 3.13 Mev J = $\frac{1}{2}$, 3.29 Mev $J^\pi = \frac{5}{2}(+)$, 3.41 Mev $J^\pi = \frac{7}{2}(+)$, 3.51 Mev $J^\pi = \frac{3}{2}(+)$. (auth)

28434 DECAY OF $^{182}_{73}$Ta. Verheul, H.; Blok, J.; Dulfer, G. H.; Jongsma, H. W.; Davidse, A. (Vrije Univ., Amsterdam). Physica, 32: 579-90(Mar. 1966).

Measurements on the direct gamma spectrum, the direct beta spectrum and the beta spectrum in coincidence with gamma rays and conversion electrons were performed on the radioactive nucleus ^{182}Ta. The results indicate the existence of five beta branches with the following maximum energies and relative intensities: (246 ± 4) kev, (31 ± 7)%; (408 ± 8) kev, (24 ± 3)%; (540 ± 5) kev, (45 ± 7)%; (1700 ± 110) kev, (0.030 ± 0.005)% and (1880 ± 150) kev, (0.020 ± 0.005)%. No evidence was found for the existence of gamma rays of 351 kev and 1437 kev as reported previously. The results are in accordance with the predictions of the unified model for the feedings of members of a rotational band. (auth)

28435 NUCLEAR REACTIONS WITH POLARIZED PARTICLES AND TARGETS. Weidenmueller, H. A. (Univ., Heidelberg). pp 12-48 of Physikertagung 1965 Frankfurt (M)-Hoechst, Okt. 4-9. Plenarvortraege. Stuttgart, B. G. Teubner Verlagsgesellschaft mbH, 1965. (In German).

For lead abstract see CONF-651030–(Vol.2) in report number index.

The polarization of a particle beam or of a target is described. The experimental methods used for the preparation and detection of polarized target beams and of polarized targets are described. Typical nuclear reactions are then discussed, and the essential data to be gained from such experiments are indicated. (J.S.R.)

28436 MUON ATOMS AND CHARGE DISTRIBUTION IN ATOMIC NUCLEI. Acker, H. L. (Univ., Freiburg i. B.). pp 2-7 of Physikertagung 1965 Frankfurt (M)-Hoechst, Okt. 4-9. Vorabdrucke von Kurzfassungen der Fachberichte. Stuttgart, B. G. Teubner Verlagsgesellschaft mbH, 1965. (In German).

For lead abstract see CONF-651030-(Vol.1) in report number index.

The development of new semiconductors with an approximate tenfold better resolution with respect to NaI counters offers new possibilities for the investigation of the charge distribution of spherical and deformed nuclei in muon atoms. In spherical nuclei the parameters of the charge distribution can be much better determined; isotope effects and hyperfine structure become measurable. Additional information is obtained in the mutual consideration of muon atoms and electron scattering (new essentially absolute measurements of the scattering cross section are necessary). In strongly deformed gg-nuclei, which even in the basic state show no quadrupole moment, its magnitude and signs can be determined from the spectrum of the muon atom. Conclusions can be drawn also on the quadrupole distribution and spherical symmetrical charge distribution of these nuclei. In deformed ug-nuclei characteristics of the nuclear structure such as the E_2 transitions between different rotational bands or the collective fraction of single-particle bands can be established. (tr-auth)

28437 INELASTIC ELECTRON SCATTERING. **Gudden, F. (Institut fuer Technische Kernphysik, Darmstadt, Ger.). pp 8-11 of Physikertagung 1965 Frankfurt (M)-Hoechst, Okt. 4-9. Vorabdrucke von Kurzfassungen der Fachberichte. Stuttgart, B. G. Teubner Verlagsgesellschaft mbH, 1965. (In German).**

For lead abstract see CONF-651030-(Vol.1) in report number index.

Since the interaction between electrons and nuclei is of an electromagnetic nature, the measurement of the inelastic scattering of high-energy electrons, which is connected with the excitation of nuclear states, yields data on the transition density of charges and magnetic moments. In light nuclei the Born approximation is applicable to the calculation of the differential scattering cross section. The experimental analysis is therefore relatively simple. In small momentum transfers the electromagnetic probabilities and a radius characteristic of the transfer can be determined independently of the model. (tr-auth)

28438 NUCLEAR STRUCTURE AND NUCLEAR REACTIONS IN LIGHT NUCLEI ACCORDING TO THE CLUSTER MODEL. Wildermuth, Karl (Univ., Tuebingen, Ger.). pp 30-6 of Physikertagung 1965 Frankfurt (M)-Hoechst, Okt. 4-9. Vorabdrucke von Kurzfassungen der Fachberichte. Stuttgart, B. G. Teubner Verlagsgesellschaft mbH, 1965. (In German).

For lead abstract see CONF-651030-(Vol.1) in report number index.

In recent years the knowledge of two-particle interactions between nucleons has greatly improved. It is therefore possible to study how the properties of nuclei can be understood as the properties of multiparticle systems from these forces. The light nuclei are especially suitable in such studies since very detailed calculations can be carried out on them because of the relatively low number of particles. In the present study the ground state of ^{6}Li and its decay into α particles plus deuterons through Coulomb excitation was described. The calculations show that it is, for instance, possible to understand the charge distribution of ^{6}Li as it results from the Hofstadter scattering experiments. It is also shown that the calculated effective cross section of the Coulomb decay of ^{6}Li agrees with the experimental effective cross section within its measurement accuracy. Preliminary calculations treating the Coulomb decay of other light nuclei were reported. A brief discussion shows how other reactions than the stripping reactions can be treated within the framework of these considerations. (tr-auth)

28439 THEORY OF GIANT RESONANCES. **Greiner, Walter (Univ., Frankfurt am Main). pp 145-9 of Physikertagung 1965 Frankfurt (M)-Hoechst, Okt. 4-9. Vorabdrucke von Kurzfassungen der Fachberichte. Stuttgart, B. G. Teubner Verlagsgesellschaft mbH, 1965. (In German).**

For lead abstract see CONF-651030-(Vol.1) in report number index.

Two methods were given for the description of giant resonances: the particle-hole model and the collective model. Both have a limited range of applicability. For nuclei in the range of magic numbers the first method is usable, but for nuclei with many nucleons outside the magic configuration the second method is usable. The results that can be obtained with both methods are discussed. These include the dipole and quadrupole sum rules, energies for the various multipole giant resonances, and the coupling of giant resonances to other collective degrees of freedom. The various decay possibilities of giant resonances were discussed. (tr-auth)

28440 THEORETICAL ASPECTS OF THE ELECTROMAGNETIC INTERACTION WITH ATOMIC NUCLEI. **Beck, F. (Technische Hochschule, Darmstadt, Ger.). pp 162-8 of Physikertagung 1965 Frankfurt (M)-Hoechst, Okt. 4-9. Vorabdrucke von Kurzfassungen der Fachberichte. Stuttgart, B. G. Teubner Verlagsgesellschaft mbH, 1965. (In German).**

For lead abstract see CONF-651030-(Vol.1) in report number index.

The study of electromagnetic interactions represents an important auxiliary for the investigation of nuclear structure. The electromagnetic interactions considered are emission, absorption, and elastic scattering of the electromagnetic radiation, elastic and inelastic scattering of charged particles, and formation states of negatively charged leptons (hyperfine interaction of electrons and muons). The processes occurring were discussed with respect to the elastic and inelastic form factors and their mutual contribution to nuclear structure investigations was described. (tr-auth)

28441 RECENT DEVELOPMENTS OF THE SINGLE PARTICLE MODEL OF ATOMIC NUCLEI. **Suessmann, G. (Univ., Frankfurt am Main). pp 223-28 of Physikertagung 1965 Frankfurt (M)-Hoechst, Okt. 4-9. Vorabdrucke von Kurzfassungen der Fachberichte. Stuttgart, B. G. Teubner Verlagsgesellschaft mbH, 1965. (In German).**

For lead abstract see CONF-651030-(Vol.1) in report number index.

The mean potential of a nucleon in the atomic nucleus can be represented over a wide energy and mass number range by a relatively simple function of the site, the velocity, the spin, and the isospin. The velocity dependence can be interpreted as a nonlocality of the potential; its origins are the velocity dependence of the nucleon-nucleon force and the Pauli principle. Such a velocity dependence can be directly confirmed by (p,2p) and (e,e'p) experiments with which the low lying single-particle levels were found. The nonlocality of the potential exerts on the particle a force so that its resonance probability in the nuclei core is smaller than that for a local potential (Perey effect). Therefore a realistic shell model potential was given. This shell model potential added to the real part of the optical scattering potential yields satisfactorily the single-particle level with its shell structure, and also reproduces the measured charge distributions within the experimental uncertaintities. (tr-auth)

28442 FINITE-RANGE EFFECTS IN QUASI-FREE SCATTERING. **Jackson, Daphne F. (Battersea Coll. of Tech., London). Proc. Phys. Soc., 88: 101-9 (May 1966).**

Finite-range effects in the quasi-free (p,pd) and (p,pα) reactions are discussed. The distinction is made between finite-range effects due to the finite size of the struck particle and those due directly to the finite range of the two-body interaction. It is shown that, while both effects are treated approximately within the framework of distorted wave impulse approximation, only the former can be included exactly within this approximation. (auth)

28443 SPIN-DEPENDENT STRIPPING THEORY OF THE REACTIONS ^{6}Li(d,p$_0$)^{7}Li AND ^{6}Li(d,p$_1$)^{7}Li* AT 2.9 Mev BOMBARDING ENERGY. **Robson, B. A. (Australian National Univ., Canberra). Proc. Phys. Soc. (London), 88: 351-3 (June 1966).**

The angular distributions observed in the ^{6}Li(d,p$_0$)^{7}Li and ^{6}Li(d,p$_1$)^{7}Li* reactions at 2.9 Mev bombarding energy are

described using the spin-dependent distorted wave theory of ordinary stripping. For both reactions the neutron may be captured with total angular momentum $j = 1/2$ or $j = 3/2$. The different cross sections at large angles are explained in terms of a relatively larger $j = 1/2$ contribution to the ground-state transition. (auth)

28444 π^+ PHOTOPRODUCTION IN ^{3}He AND NUCLEAR FORM FACTORS. Koester, L. J. Jr.; O'Fallon, J. R.; Smith, J. H.; Yavin, A. (Univ. of Illinois, Urbana). pp 47-50 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

Differential cross sections for the reaction $\gamma + {}^3\text{He} \rightarrow \pi^+ + {}^3\text{H}$ were measured at four angles in the center-of-mass system and the triton laboratory system. An impulse approximation was used to interpret the results. On the basis of the results, the dependence of the nuclear form factors on the momentum transfer was studied. (D.C.W.)

28445 PROTON BINDING ENERGIES IN NUCLEI THROUGH (e,e'p) INELASTIC SCATTERING AROUND 600 Mev. Amaldi, U. Jr.; Venuti, G. Campos; Cortellessa, G.; Fronterotta, G.; Hillman, P.; Reale, A.; Salvadori, P. (Istituto Superiore di Sanita, Rome). pp 136-40 of Proceedings of the International Symposium on Electron and Photon Interactions at High Energies. Vol. II. Hamburg, Deutsche Physikalische Gesellschaft e. V., 1966.

The problem of measuring nucleon binding energies in nuclei is analyzed. The use of (p,2p) and (e,e'p) reactions for such measurements is discussed with emphasis on the latter reaction. The merits of using higher incident energies are considered, and some experimental results obtained using both reactions are presented. (D.C.W.)

28446 THE EUROPIUM ISOTOPES ^{142}Eu, ^{143}Eu AND ^{144}Eu. Malan, H. P.; Muenzel, H.; Pfennig, G. (Nuclear Research Centre, Karlsruhe, Ger.). Radiochim. Acta, 5: 24-8(Mar. 1966).

Two short-lived activities, with half lives of 2.61 ± 0.03 and 1.2 ± 0.2 min, were produced by (d,xn) reactions on ^{144}Sm. On the basis of chemical separations and their genetic relations these activities were assigned to ^{143}Eu and ^{142}Eu, respectively. Gamma rays of 1.11 and 1.55 Mev are associated with the decay of ^{143}Eu, and those of 0.77 and 1.03 Mev with the decay of ^{142}Eu. Reported data on ^{141}Eu could not be confirmed. The half life of ^{143}Sm was redetermined as 8.84 ± 0.02 min. Analysis of the gamma spectra yielded a new gamma ray of 1.52 Mev. (auth)

28447 CROSS SECTIONS OF SOME (n,p) AND (n,α) REACTIONS INDUCED BY 14.8-Mev NEUTRONS. Kjelberg, A.; Pappas, A. C.; Steinnes, E. (Univ. of Oslo). Radiochim. Acta, 5: 28-30(Mar. 1966).

Cross sections for (n,p) and (n,α) reactions induced by 14.8-Mev neutrons in zinc and bromine were determined by radiochemical methods and using the ^{31}P(n,p)^{31}Si reaction as monitor. For the previously unreported cross section of ^{79}Br(n,p)^{79m}Se a value of 10 ± 3 mb was found. (auth)

28448 THE YIELD OF ^{72}Zn IN THE THERMAL AND EPI-CADMIUM NEUTRON FISSION OF ^{239}Pu. Fritze, K. (McMaster Univ., Hamilton, Ont.). Radiochim. Acta, 5: 57-8(Mar. 1966).

Yields of ^{72}Zn from the fission of ^{239}Pu by thermal and epi-cadmium neutrons were investigated. To check the validity of the ^{72}Zn measurements ^{115}Cd was also isolated. The estimated error for the ^{72}Zn ratios was based on the uncertainty in the ^{72}Ga activity from the cadmium-wrapped samples. There seemed to be a small but definite decrease in the ^{72}Zn yields in the epi-cadmium fission of ^{239}Pu.

28449 CONTRIBUTION TO THE STUDY OF THE INTERNAL CONVERSION ELECTRON SPECTRUM EMITTED IN THE DECAY OF ^{226}Ra. Da Silva, Maria Teresa (Faculdade de Ciencias, Lisbon). Rev. Fac. Cien., Univ. Lisboa, 2a, Ser. B, 10: 5-6(1963-1964). (In Portuguese).

The internal conversion electron spectrum of the 187-kev radiation emitted during the α decay of ^{226}Ra was studied using the nuclear emission technique. The internal conversion coefficients α_t and α_K and, for the first time, α_L and α_{M+} were determined. There is satisfactory agreement between the theoretical and experimental results for α_K. The experimental results for α_L, α_{M+}, and α_t are slightly less than the theoretical values; however the determination for α_t has the best agreement of all experimental results with the theoretical value. The conversion ratios for the various electron shells were found, making it possible to confirm the electric polarity of the 187-kev radiation. The fluorescence yield of radon was determined, and the value found was in good agreement with theory. (tr-auth)

28450 ABNORMAL CROSS SECTIONS OF GOLD NUCLEI OBSERVED DURING IRRADIATIONS OF ^{238}U BY ^{22}Ne IONS. Wang, Tung-sheng; Yeh, Wei-wen; Ma, Chuntsan. Sci. Sinica (Peking), 15: 329-35(Mar. 1966). (In Russian).

Gold isotopes were separated by the radiochemical method from the reaction ^{238}U(^{22}Ne,f). The gold isotopes were identified by means of the x-ray spectra and other methods. The cross section of the ^{199}Au isotope was measured as 5×10^{-27} cm^2. This cross section is three orders higher than that obtained from extrapolation on the well known fission curve for ^{238}U(^{22}Ne,f). The formation of the gold isotope ^{199}Au with cross section of about a millibarn in this reaction can not be explained by means of the transmission nuclear reaction. Some explanations are given for this abnormal phenomenon. (tr-auth)

28451 EXCITATION AND IONIZATION OF ATOMS BY BETA DECAY. Skorobogatov, G. A. (Leningrad State Univ.). Teor. Eksp. Khim., 2: 26-36(Jan.-Feb. 1966). (In Russian).

It was shown that in the calculation of the probability of excitation and ionization of atoms by β decay for the elements from Li to Kr, the theory using the 1-electron hydrogen-like wave functions and Slater screening constants seems very satisfactory. Numerical results for the β decay was given for all valent states of the element from Li to Kr. (tr-auth)

28452 ATOMIC MASSES AND NUCLEAR STABILITY. Duckworth, H. E. (Univ. of Manitoba, Winnipeg, Can.). Trans. Roy. Soc. Can. (4), 3: 167-73(1965).

A brief review of the structure of atoms is given. Spectroscopic mass determinations are discussed, and nuclear structure is considered. Double neutron separation energies are plotted for some isotopes. It concluded that precise determinations of atomic mass differences can provide useful evidence for the ground-state structure of nuclei. (J.F.P.)

28453 TOTAL NEUTRON CROSS SECTIONS OF ^{162}Er FOR SLOW NEUTRONS. Vlasov, M. F.; Vertebnii, V. P.; Kirilyuk, A. L.; Pasechnik, M. V.; Trofimova, N. A. (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 11: 240-4(Mar. 1966). (In Ukrainian).

The total neutron cross sections of erbium-162 were measured by the time-of-flight method over an energy range of 0.1−0.005 ev. The value of the cross section at 2200 m/sec is 200 ± 25 barn. The known value of the activation cross section for 75 min activity is equal to 2.03 ± 0.20 barn. This discrepancy can be understood if the existence of other (isomeric) activities of erbium-163 is assumed. (auth)

28454 TWO-PROTON RADIOACTIVITY (POSSIBILITIES FOR DETECTION AND ANALYSIS). Gol'danskii, V. I. Usp. Fiz. Nauk, 87: 255-72(Oct. 1965). (In Russian).

A review is given of spontaneous transmutation of chemical elements by proton emission. The theoretical basis of this mechanism is discussed and a close analogy is drawn between this phenomenon and tunnel transition of electrons between metals in the superconductive and normal states due to a difference in potentials exceeding the width of the energy gap in the superconductor. Formulas are given for determining the rate of two-proton decay. An energy diagram is given illustrating the difference between levels for proton decay and two-proton decay. The nature of the angu-

lar and energy correlations between the two protons emitted in 2p-decay are mathematically analyzed. The various nuclei in which two-proton radioactivity is possible are enumerated on the basis of theoretical considerations. A graph is given summarizing the available data on the energy of two-proton decay of neutron-deficient isotopes of even elements from oxygen to osmium. (ATD)

28455 PROBABILITY OF ISOMERISM IN DECAY OF HEAVY EXCITED NUCLEI. Zommer, V. P.; Prokof'ev, A. I. Yadern. Fiz., 3: 401-5(Mar. 1966). (In Russian).

A method of calculating the isomerism ratio is described for an arbitrary nuclear reaction on heavy nuclei, under the condition, that the competitive processes are fission and emission of neutrons and γ quanta. Theoretical results are obtained for the reaction $^{242}Pu(d,2n)^{242}Am$ and are in good agreement with the experimental data. It follows from the comparison with experiments, that the energy of the isomer state in the ^{242}Am nucleus, decaying through spontaneous fission with the period 14 msec, is 2.8 Mev. (auth)

28456 THEORY OF μ CAPTURE IN NUCLEI. Novikov, V. M.; Urin, M. G. Yadern. Fiz., 3: 419-31(Mar. 1966). (In Russian).

Muon capture in nuclei is considered on the basis of the Fermi-liquid theory for finite systems. It is shown that the quasiparticle interactions decrease the capture probability 1.5–2 times. This makes it possible to eliminate the systematical discrepancy between the shell-model calculations and experimental data. The μ-capture probability was calculated in the quasiclassical approximation for nuclei in a broad region of atomic weights. It is shown that the relative contribution of transitions with different multipolarities differs significantly for medium-weight nuclei and heavy ones. (auth)

28457 ANGULAR DISTRIBUTION OF γ QUANTA IN THE MULTIPLE COULOMB EXCITATION OF NUCLEI. Berson, I. (Inst. of Physics, Academy of Sciences, Latvian SSR). Yadern. Fiz., 3: 457-60(Mar. 1966). (In Russian).

The coefficients in the angular distribution of γ quanta, emitted after the Coulomb excitation of rotational levels in even-even nuclei, are calculated. The contribution of cascade transitions to the angular distribution of γ quanta is taken into account. (auth)

28458 COULOMB EXCITATION OF ELECTRIC OCTUPOLE TRANSITIONS IN ^{115}In NUCLEI. Gangrskii, Yu. P.; Lemberg, I. Kh. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz., 3: 461-4(Mar. 1966). (In Russian).

The Coulomb excitation of levels in ^{115}In, which are deexcited to the ground state through cascades envolving the isomeric 335-kev level of ^{115}In (T = 4.5 hours), was investigated. The excitation of the levels was measured according to the yield of 335-kev γ quanta. The observed dependence of the yield on the α-particle energies can be explained by the electric octupole excitation of two groups of levels, the energies of which are known from other spectrometric experiments. The levels 0.595 and 0.825 Mev belong to the first group, those with the energies 2.06, 2.17, and 2.49 Mev to the second one. It seems that the levels in the second group are analogous to the 3^- excited states in the neighboring even isotopes of Cd and Sn. (auth)

28459 CHANNEL ANALYSIS OF ^{238}Pu NEUTRON FISSION. Vorotnikov, P. E.; Dubrovina, S. M.; Otroshenko, G. A.; Shigin, V. A. Yadern. Fiz., 3: 479-86 (Mar. 1966). (In Russian).

The results of cross-section and angular-distribution measurements of the ^{238}Pu neutron-fission fragments, with energies between 50 and 1400 kev, are given. The obtained results are analyzed so as to separate the individual fission channels, differing with respect to K the projection of the fissioning nucleus angular momentum on to its symmetry axis. It is shown that the channels with different K occur in the consequency $1/2^-$, $3/2^-$, $1/2^+$. The values of the thresholds, fission widths and fission barrier curvatures were determined for each channel. The results, together with data on ^{239}Pu photofission, show that the form of the fission barrier is almost parabolic, and made it possible to determine the dipole photo-absorption cross section for the ^{239}Pu nucleus. (auth)

28460 INTERACTIONS OF 7.2-Gev/c π MESONS WITH NUCLEI, FOLLOWED BY EMISSION OF FAST PARTICLES. Assovskaya, A. S.; Lepekhin, F. G. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz., 3: 487-8(Mar. 1966). (In Russian).

Interactions of 7.2-Bev/c mesons (π) with heavy nuclei, accompanied by the emission of 3 and 4 fast particles, were investigated with the help of the NIKFI–R emulsion. The estimation of the charged meson (K) creation cross section in the momentum region 200–1200 Mev/c does not contradict values, obtained previously. (auth)

28461 THE γ SPECTRUM OF ^{56}Mn. Voinova, N. A.; Dzhelepov, B. S.; Kalinichev, Yu. V.; Kaminker, D. M.; Sergeev, A. G. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz., 3: 593-7(Apr. 1966). (In Russian).

The γ-spectrum of ^{56}Mn is measured by means of the magnetic spectrometer of the elotron type. The γ-transition energy is obtained with 0.03 to 0.04% accuracy. Since the scheme of the ^{56}Mn decay is well known, the measurement of the ^{56}Mn spectrum improved the energy calibration of the spectrometer in the region of energy higher than 1.4 Mev and gave the best values for the energy of the ^{56}Fe levels, excited in the ^{56}Mn decay. The intensities of the ^{56}Mn γ-transitions are determined. (auth)

28462 γ RADIATION OF ^{85}Sr. Vartanov, N. A.; Samoilov, P. S.; Tsaturov, Yu. S. Yadern. Fiz., 3: 598-601(Apr. 1966). (In Russian).

The γ radiation of ^{85}Sr was carefully investigated. It was found that 880 kev γ-quanta are emitted in addition to the well-known 514 kev ones. The relative intensities of these lines are equal to 0.010 ± 0.002 and 100 respectively. It was shown convincingly, that the 1220 kev γ-line previously attributed to ^{85}Sr, is absent in the γ spectrum of ^{85}Sr. (auth)

28463 CONVERSION ELECTRON SPECTRA OF THE ^{135}Ce, ^{133}Ce, AND ^{132}Ce ISOTOPES. Abdumalikov, A. A.; Abdurazakov, A. A.; Buribaev, S. B.; Gromov, K. Ya.; Lebedev, N. A. (Joint Inst. for Nuclear Research, Dubna, USSR. Tashkent Polytechnic Inst.). Yadern. Fiz., 3: 602-8(Apr. 1966). (In Russian).

A β-spectrograph with a constant magnetic field was used to study conversion electron spectra in the decay of the ^{135}Ce, ^{133}Ce, and ^{132}Ce isotopes in the energy region 20 to 800 kev. The following new γ-transitions were found in the decay of ^{135}Ce: 86.80 (E2 + M1), 146.0, 200.7 and 267.5 kev; in the decay of ^{133}Ce: 87.8 (M1), 123.7, 127.8, 130.7 (M1 + E2), 137.6, 142.3, 155.5 (M1 or E1), 177.1, 178.6, 182.2 (E1 or M1 + E2), 190.1 (M1 or E1), 216.8, 251.5, 261.3 and 329.5 kev; in the decay of the ^{132}Ce: 76.8 (M1), 97.1 (M1) and 174.0 kev. It is assumed that the 97.1 and 174.0 kev levels are excited in the ^{132}La nucleus. The decay scheme for $^{135}Ce \rightarrow {}^{135}La$ is proposed. (auth)

28464 INVESTIGATION OF THE γ SPECTRA OF ^{74}Br ISOTOPE. Belyaev, B. N.; Gvozdev, B. A.; Gudov, V. I.; Kalyamin, A. V.; Krizhanskii, L. M. Yadern. Fiz., 3: 609-13(Apr. 1966). (In Russian).

The γ spectra of Br isotopes, obtained in the reaction $Cu(^{12}C,xn)Br$, are investigated using a scintillation spectrometer. The energies and relative intensities of a number of new γ lines in bromine with the decay half-times 36 ± 1 and 4 ± 1 min were measured. The energies and relative intensities are given for γ-lines with $T_{1/2} = 36$ min. The isotope with $T_{1/2} = 36 \pm 1$ min was identified as ^{74}Br. A scheme of the lower energy levels in ^{74}Se is given. (auth)

28465 REACTION $^{11}B(p,\alpha_0)^8Be$ WITH POLARIZED 130- TO 300-kev PROTONS. Ad'yasevich, V. P.; Antonenko, V. G. Yadern. Fiz., 3: 649-51(Apr. 1966). (In Russian).

The angular distribution of α particles in the reaction $^{11}B(p,\alpha_0)^8Be$ for a nonpolarized target and polarized protons is calculated from the experimental data on this re-

action, obtained using nonpolarized 130 to 300 kev protons and a nonpolarized target. It is shown that it is possible to determine the degree of polarization of the incident beam and the phase shift of the reaction channels. (auth)

28466 INVESTIGATION OF THE $^{10}B(\alpha,p_0)^{13}C$ REACTION. Spasskii, A. V.; Teplov, I. B.; Fateeva, L. N. (Moscow State Univ.). Yadern. Fiz., 3: 652-6(Apr. 1966). (In Russian).

The excitation functions and angular distributions of the ground state proton group in the reaction $^{10}B(\alpha,p_0)^{13}C$, were measured for α-particles in the energy region 9.5 to 26 Mev. The obtained angular distributions and their energy dependence cannot be interpreted with the help of the theory of stripping and knock-out processes. It follows that compound nucleus formation and possibly more complex direct processes make a considerable contribution to the reaction mechanism. (auth)

28467 NEUTRON POLARIZATION IN THE $^{12}C(d,n)^{13*}N$ REACTION WITH $l_p = 0$ AT $E_d = 6$ Mev. Babenko, N. P.; Bibichev, B. A.; Nemilov, Yu. A. Yadern. Fiz., 3: 663-6 (Apr. 1966). (In Russian).

The angular dependence of the polarization of a neutron group from the reaction $^{12}C(d,n)^{13*}N$ with $l_p = 0$ is measured for the first excited state of the ^{13}N nucleus at $E_d = 6$ Mev. The polarization is found to be positive for angles in the region 30 to 80° (l.s.) and takes the maximal value 27% at. the angle 71°. (auth)

28468 TOTAL NUCLEAR DISINTEGRATION REACTIONS. Shumilov, S. N.; Klyucharev, A. P.; Rutkevich, N. Ya. Yadern. Fiz., 3: 667-71(Apr. 1966). (In Russian).

The $^{14}N + ^{10}B \rightarrow 6\alpha$ reaction produced by interaction of ^{10}B ions, accelerated to 100 Mev, with ^{14}N nuclei in the photoemulsion is investigated. The angular distribution of α-particles has maxima in the forward and backward directions. The reaction cross section, equal to 40 millibarns, is compared with the cross section of the reaction $^{12}C + ^{12}C \rightarrow 6\alpha$. It is shown there are no compound nucleus formation in the reaction $^{14}N + ^{10}B \rightarrow 6\alpha$. (auth)

28469 PHOTOSPALLATION OF ^{12}C. Bazhanov, E. B.; Komar, A. P.; Kulikov, A. V.; Ogurtsov, V. I. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz., 3: 711-18 (Apr. 1966). (In Russian).

The excitation function of photoneutron reactions on the ^{12}C nucleus was investigated for 18 to 52 Mev γ-radiation by detecting previously slowed-down neutrons with the help of boron counters. Well resolved maxima were observed in the giant resonance region at 20.9; 22.0; 23.5 and 25.0 Mev. The results were compared with other measurements and with shell-model calculations, taking particle-hold interactions into account. Contrary to the theoretical predictions, no peaks with integral cross sections larger than 1 Mev·mbn were observed for γ-radiation in the region 31 to 36 Mev. (auth)

28470 CROSS SECTION OF FRAGMENT PRODUCTION BY 660-Mev PROTON REACTIONS WITH Yb, Er, AND Tb NUCLEI. Kon'shin, V. A.; Matusevich, E. S.; Regushevskii, V.I. Yadern. Fiz., 3: 778(Apr. 1966). (In Russian).

The number of fragments causing visible damage in glass in 660-Mev proton irradiation of Yb, Er, and ^{159}Tb targets was measured; the energy threshold for recording the fragments was on the order of 10 to 15 Mev. Results are shown. The measured cross sections are due to both fission and spallation reactions. (M.J.T.)

28471 THE TECHNICAL SIGNIFICANCE FOR MEASUREMENT OF THE MOESSBAUER EFFECT. Banerjee, Prabuddha. Z. Instrum., 74: 19-24(Jan. 1966). (In German).

The theory of the Moessbauer effect is developed using the laws of classical physics. A principal experimental setup is described that allows the study of the Moessbauer effect. Some applications are discussed in which the properties of nuclei and the surrounding medium can be investigated. Such applications includes testing of Einstein's general relativity theory, lifetimes of nuclear states, nuclear moments, and nuclear radii. In the area of solid state physics and chemistry, Moessbauer effects of higher order such as that sketched for ^{57}Fe may be used for studies of isomer shift, magnetic hyperfine structure, and quadrupole splitting. Use of the effect in the study of noncrystalline materials, viz., glasses, solutions, and giant molecules, is suggested. (BBB)

28472 THE DECAY OF ^{109m}In (0.21 sec). Weirauch, W.; Schmidt-Ott, W.-D.; Smend, F.; Flammersfeld, A. (Univ., Goettingen, Ger.). Z. Phys., 192: 351-7(1966). (In German).

^{109m}In (0.21 ± 0.01) was produced from natural Ag and enriched ^{107}Ag by α irradiation and investigated using scintillation spectrometers and coincidence techniques. The mass assignment follows from the excitation function for the (α, 2n) reaction on ^{107}Ag. The following results were obtained: energy of the isomeric level (2.11 ± 0.02) Mev, determined directly by summing up the cascade transitions in a well-type scintillator; four gamma transitions with energies (0.680 ± 0.015), (0.405 ± 0.015), (1.035 ± 0.030) and (1.435 ± 0.020) Mev, respectively. The proposed decay scheme contains the isomeric level ($^{19}/_2^+$) at 2.11 Mev and a further level ($^{13}/_2^+$) at 1.435 Mev which decays either by the 1.435 Mev transition (80 ± 3)% or by a 0.405–1.035 Mev cascade (20 ± 3)% via an ($^{11}/_2^+$) level at 1.035 Mev to the $^9/_2^+$-ground state of ^{109}In. (auth)

28473 MEASUREMENT OF LIFETIME OF EXCITED NUCLEAR LEVELS OF ^{28}Al, ^{133}Cs, ^{141}Pr, ^{182}W, AND ^{195}Pt. Bloess, D.; Krusche, A.; Muennich, F. (Technische Hochschule, Brunswick). Z. Phys., 192: 358-78(1966). (In German).

The halflife of excited states in some nuclei was measured by the method of delayed coincidences. Two different experimental arrangements were used: a conventional scintillation counter equipment and a fast gas-filled parallelplate avalanche-counter. The results of these measurements are given. The experimental values are discussed and compared with theoretical model predictions. (auth)

28474 ENERGY LEVELS IN ^{74}Ge FROM THE REACTION $^{73}Ge(n,\gamma)^{74}Ge$. Weitkamp, C.; Michaelis, W.; Schmidt, H.; Fanger, U. (Kernforschungszentrum, Karlsruhe, Ger.). Z. Phys., 192: 423-38(1966).

The level structure of ^{74}Ge was investigated at the research reactor using thermal neutron capture in ^{73}Ge. Neutrons were monochromized by Bragg reflection from a lead single crystal. The target was ^{73}Ge enriched to 86.1%. Precision measurements of the capture gamma-ray spectrum were performed over the whole energy range by means of a 4 $cm^2 \times 3.5$ cm lithium-drifted germanium detector. 148 gamma transitions were observed. Considerable aid in analysis of the level structure is provided by double and triple coincidence measurements with 4″ø × 5″ NaI(Tl) detectors. Data were processed using the Karlsruhe Multiple Input Data Acquisition System (MIDAS). A level scheme of ^{74}Ge is proposed involving 38 excited states in the energy range from 0 to 4400 kev. The neutron binding energy of ^{74}Ge is determined to be 10,202 ± 10 kev. (auth)

28475 STRIPPING CROSS SECTION FOR $^4He(d,p)^5He$ UNDER THE ASSUMPTION OF CLUSTER STRUCTURES IN THE FINAL NUCLEUS. Henneberg, P. (Max Planck-Institut fuer Chemie, Mainz. Oklahoma State Univ., Stillwater). Z. Phys., 193: 23-36(1966).

The differential cross section for the reaction $^4He(d,p)^5He$ is calculated assuming cluster configurations in the residual nucleus. The processes leading to the ground state and to the second excited state of ^5He are studied. The former is described by an α particle—neutron configuration the latter by a triton—deuteron structure. Complete antisymmetrization of the wave functions, and thus exchange terms in the stripping amplitude are taken into account. The computed cross sections in the two cases differ appreciably in magnitude as well as in the angular distribution from one another. (auth)

28476 RANGE DISTRIBUTION OF ISOBAR SERIES AND RANGE OF FRAGMENTS FROM THERMAL ^{239}Pu

FISSION. Hollstein, M. Karlsruhe, Ger., Technische Hochschule, 1965. 78p. $2.00 Gmelin, AED-Diss. 65-254.

Range distributions of ^{140}Ba and ^{127}Sb in Al were studied with stripping methods. Average ranges are 2.9 and 3.6 mg Al/cm^2 respectively. A new technique for direct range determinations in Al is described. Fragment ranges of ^{139}Ba and ^{139}Cs are given. (Gmelin Inst.)

28477 CALCULATION OF BINDING ENERGY OF λ PARTICLES IN NUCLEAR MATTER USING AN EFFECTIVE λ-NUCLEON POTENTIAL. Ranft, G. (Leipzig, Univ., 1965. 111p. $2.00 Gmelin, AED-Diss. 65-277.

An effective Λ-nucleon potential is given. Theoretical results are in agreement with low energy Λ-nucleon scattering data. Central and tensor parts of this potential are used for binding energy calculations in first and second Born approximation. Contribution of tensor potential is negligible. (Gmelin Inst.)

28478 MEASUREMENTS OF ANGULAR CORRELATIONS OF γ-γ CASCADES OF ^{83}Br. Reimel, K. Munich, Technische Hochschule, 1964. 41p. $2.00 Gmelin, AED-Diss. 64-1066.

The design and construction of a multiple angle five-detector apparatus for the determination of the whole angular correlation function in one measurement is described. Correlation data of the following two cascades of ^{83}Br are given: 1.01−1.01 Mev and 0.83−0.52 Mev. (Gmelin Inst.)

Plasma Physics and Thermonuclear Processes

See also Fluid Physics and Thermodynamics

Refer also to abstracts 27662, 27663, 27728, 28085, 28090, and 28107.

28479 (AD-631469) CHARACTERISTICS OF METAL VAPOR. Wechsler, A. E. (Little (Arthur D.) Inc., Cambridge, Mass.). Jan. 1966. Contract AF 33(657)-11735. 78p. (ARL-66-0004). CFSTI $3.00 cy, $0.75 mn.

Radiation attenuation properties of alkali metal vapors and their effects on the radiation heat transfer characteristics of arc and plasma systems were investigated. An absorption cell used to measure the transmittance of sodium, potassium, and cesium vapor over the temperature range from 300 to 900°K with alkali partial pressures of 10^{-3} to 40 torr is described. A grating spectrometer was used with the cell to obtain data over the wavelength region from 0.2 to 1.0 μ. Strong widespread absorption in the visible and near infrared regions caused by band absorption of the alkali metal molecules and absorption in narrow regions surrounding the first principal series lines of the alkali metal atoms were noted. Molecular absorption cross section values, calculated from plots of transmittance versus the effective vapor path length in the absorption cell, varied from 0.1 to 30 Å^2, depending upon the alkali metal type and wavelength. The molecular cross sections for cesium were larger than for potassium; sodium had the smallest cross section. Effective atomic absorption cross sections were calculated in the regions where atomic absorption was dominant. Sample calculations based upon the measured cross sections indicated that up to 30% of the radiation emitted by a source at 10,000°K could be absorbed in a 2.5-cm layer of alkali metal vapor (cesium) in equilibrium at 400°C. (auth)

28480 (AD-631992) STATISTICAL MECHANICAL THEORY OF DENSE PLASMAS. Sandri, G.; Sullivan, R.; Kritz, A.; Schatzman, F. (Aeronautical Research Associates of Princeton, Inc., N. J.). Jan. 1966. Contract AF33(615)-1910. 278p. (ARL-66-0009). CFSTI $6.00 cy, $1.50 mn.

The physical and mathematical tools are developed for the analysis of the behavior of plasmas for which the Bogolubov conditions, $(e^2/kT)\,(1/\lambda_D) = (n\lambda_D^3)^{-1} \ll 1$, do not hold. The higher order terms in $(n\lambda_D^3)^{-1}$, for all observable quantities depend on three- and four-body correlations. It is shown that a direct calculation with Bogolubov's technique leads to divergent results. A method is described which is believed to be a far-reaching generalization of Bogolubov's. The emphasis of the classical analysis, in terms of sharply localized particle collisions, is shifted by this method to an analysis of the time scales on which the phenomena evolve. This shift leads to a new view of kinetic equations. An analysis is given of the three-body correlations which relies on our recent solution of the three-body problem for hard spheres. The nth order term in the Bogolubov expansion was obtained. An externally controlled test particle is then introduced in order to probe into the properties of these correlations and to develop rigorously the corresponding statistical theory. As an application of the theory, the complete solution was obtained for the lowest order distribution function in one dimension which coincides exactly with the non-linear Debye-Huckel theory. It was shown that three-body correlations appear one order sooner than when the test particle is absent. The transition to the macroscopic (or "fluid") description is carried out by an appropriate expansion, and the transient behavior of the important moments is described. Finally, the techniques developed are utilized to discuss correlation functions among many particles. (auth)

28481 (AD-632318) LINEARLY POLARIZED WAVES IN PLASMAS IN THE REGION OF THE ELECTRON CYCLOTRON FREQUENCY. Scientific Report No. 3. Bachynski, M. P.; Gibbs, B. W. (RCA Victor Co., Ltd., Montreal (Quebec). Research Labs.). Jan. 1966. Contract AF19(628)-4071. 23p. (AFCRL-66-137). CFSTI $1.00 cy, $0.50 mn.

Linearly polarized incident electromagnetic waves were propagated along the direction of a static magnetic field through a helium after-glow plasma in the frequency region of the electron cyclotron frequency. The experimental measurements illustrate clearly the behavior of the two transverse wave modes that the plasma can support. At high electron densities the right-hand circularly polarized component is completely attenuated and the variation of the transmitted signal is due entirely to the left-hand circularly polarized component. Alternately at low electron densities the plasma is transparent to the left-hand mode and the variation in transmitted signal is due to the right-hand mode. Detailed comparisons of measurements of the phase and intensity of the components of the electric field transmitted through the plasma in the same orientation as the incident polarization and cross-polarized to the incident polarization show good agreement with theory. (auth)

28482 (CLM-R-53) A COMPUTER PROGRAM FOR THE DESIGN OF HIGH-PERVEANCE ION SOURCES. Bate, D. G. (Culham Lab., United Kingdom Atomic Energy Authority, Abingdon (England)). Jan. 1966. 43p. Dep. mn. BIS $1.20. HMSO 6s.

The use of a digital computer program to calculate ion trajectories in the extraction region of high perveance plasma ion sources is described. The effects of electric fields, magnetic fields, and space charge are included in the calculations and the plasma boundary shape and position can be determined for plasmas whose density distribution is known. Examples are given of the types of problems which were studied by this method. Complete instructions for the use of the program, illustrated by the input and output of a sample problem are presented. (auth)

28483 (CLM-R-55) CURRENT-INDUCED PUMP-OUT. Hotston, E. S.; Wort, D. J. H. (Culham Lab., United Kingdom Atomic Energy Authority, Abingdon (England)). Dec. 1965. 32p. Dep. mn. BIS $0.90. HMSO 4s. 6d.

Afterglow plasmas in hydrogen and deuterium produced in a toroidal device were shown to be quiescent. A typical afterglow had an electron density of 4×10^{13} cm^{-3} near the bore center, with the electron and ion temperatures substantially equal at 3200°K in this region. Near the torus

wall the ion temperature fell to approximately one half of the electron temperature. This plasma was produced in an axial magnetic field of 150 to 500 gauss, and decayed by classical diffusion and recombination processes with a lifetime of 200 μsec. An instability was induced in this plasma by causing a current of 1-2 A cm^{-2} to flow in it. This instability caused a rapid loss of plasma ("pump-out"), and was outwardly very similar to the pump-out induced in the Stellarator, reported by Motley. The same criterion for the current required to cause pump out was applicable, but it was found that this criterion is incorrect, as the seat of the instability lies in the tenuous post pump-out rather than the pre-pump out plasma. The correct criterion is given by Jackson, and it was found that this criterion was obeyed within a factor of five. There is no difficulty with the apparent absence of ion Landau damping which Motley required for his drift criterion to be valid. The instability, after starting in the low density plasma near the inner wall of the torus, propagated outwards, creating a low density plasma suitable for its own maintenance as it proceeded. (auth)

28484 (FEI–18) IZMERENIE ELEKTRONNOI TEMPERATURY V TSEZIEVOI NIZKOVOL'TNOI DUGE. (Measurement of Electron Temperature in Cesium Low-Voltage Arc). Gus'kov, Yu. K.; Kiryushchenko, A. I.; Lebedev, M. A.; Morozova, G. G. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). 1965. 8p. Dep. mn.

The electron temperature T_e was determined at a low pressure of cesium vapor (0.1 to 1 torr) with an inter-electrode spacing of 6 mm. The electrode temperature was measured with a chromel-aluminum thermocouple. The intensity of the recombination radiation each 0.4 mm was recorded on film in a spectrograph with a linear resolution of 0.2 mm. On assuming a quasineutral plasma with a Maxwellian distribution of electron energies, the electron temperature could be determined from the slope of a plot of the radiation intensity as a function of the frequency of the radiation. With a cathode temperature of 1100°K, an anode temperature of 800°K, a cesium vapor pressure of 0.1 torr the electron temperature T_e at the cathode was a maximum of 4000°K at a distance of about a mean free electron path length ($l_0 = 6 \times 10^{-2}$ cm). Then the value of T_e dropped sharply to 2000°K, and an increase in T_e was observed at the anode. The electron temperature was almost constant along the gap. (TTT).

28485 (D–1–82–0512) ONSET OF TURBULENCE IN THE POSITIVE COLUMN. Hoh, F. C. (Boeing Scientific Research Labs., Seattle, Wash. Plasma Physics Lab.). Feb. 1966. 13p.

A discussion is presented of a physical stabilization mechanism of the helical instability of the positive column in a longitudinal magnetic field due to quasi-linear effects. The quasi-linear steady state, consisting of a density helix rotating around the axis, is then perturbed and a chain of linearized differential equations results. When this state next becomes unstable, a coupled set of helical modes with the same growth rate are excited simultaneously, thus leading to the onset of turbulent behavior. Finally, the boundary condition and the corresponding expansion of the eigenfunction of the linearized problem, which was arbitrarily chosen previously, is reconstructed. (M.O.W.)

28486 (IAE–1016) PROKHOZHDENIE PLAZMENNYKH SGUSTKOV CHEREZ PRODOL'NYE MAGNITNYE POLYA. (Passage of Plasmoids Through Longitudinal Magnetic Field). Vasil'ev, V. I.; Komel'kov, V. S.; Tserevitinov, S. S. (Institut Atomnoi Energii, Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). 1965. 16p. Dep. mn.

By means of thermal and diamagnetic probes, the Thomson spectrometer, photomultiplier monochromator, and other methods, the structure of plasmoids of deuterium plasma generated by coaxial injectors, the impurity distribution, and the passage of plasmoids through pulsed barrier magnetic fields were investigated. It was established that the longitudinal magnetic fields with corkscrew geometry of 15 kgauss effectively retards the plasma with density of 5 to 20 × 10^{14} cm^{-3} moving with a velocity of 20 to 6 × 10^6 cm/sec. With the selection of the size of the field and moment of its insertion, it is possible to separate the impure ion admixture rear portion of the plasmoid from its frontal clear ionization part. The experimental results are compared with theory. (tr-auth)

28487 (JINR–P–2648) K KVAZILINEINOI TEORII APERIODICHESKIKH NEUSTOICHIVOSTEI. (On a Quasilinear Theory of Aperiodic Instabilities). Perel'shtein, E. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1966. 8p. Dep. mn.

The problem is considered as to how the qualitative results of the quasilinear theory of aperiodic instabilities depend on the initial distribution function. The aperiodic instabilities are known to be determined by the collective interaction of all the particles and it seems that the results of the theory must not depend on the character of the distribution function. It is shown that the closing of instabilities in the quasilinear theory depends essentially on a form of the initial distribution function. (auth)

28488 (JUL–314–PP) PRODUCTION OF A HIGH-VELOCITY COLLISIONLESS PLASMA PULSE. Bieger, W.; Tuczek, H. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Plasmaphysik). Oct. 1965. 12p. (CONF–650806–23). Dep. mn.

From 7th International Conference on Phenomena in Ionized Gases, Belgrade.

By interaction with a moving inhomogeneous magnetic field, produced by a traveling wave on a special transmission line, plasma is accelerated. If collisions between the ions are negligible in the plasma, pulses with a homogeneous radial density distribution and velocities up to 10^8 cm/sec are observed. The reflection mechanism of the ions by the magnetic field can be described by a free particle model in good agreement with the measurements. Losses of particles, due to a leakage on the axis of the field and due to scattering are studied by measurements with an ion spectrometer and a microwave interferometer. (auth)

28489 (JUL–339–PP) EXPERIMENTE ZUR ERZEUGUNG EINES CUSP-FOERMIGEN PLASMAS DURCH SCHNELLE MAGNETISCHE KOMPRESSION. (Experiments on the Production of a Cusp-Shaped Plasma by Fast Magnetic Compression). Belitz, H.-J.; Kugler, E. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Plasmaphysik). Dec. 1965. 41p. Dep. mn. mn.

The construction of a 10 kjoule cusp compression experiment and the measurements carried out with it were described. The construction corresponds to that of two 5 kjoule θ pinch experiments; some characteristics were discussed. The measurements showed a strong influence of preheating on the results of the primary discharge. The processes in the preheating phase were described in detail. In the primary discharge a cusp-shaped plasma was obtained with an electron density up to 5 × 10^{17} cm^{-3} at electron temperatures between 10 and 70 ev. (tr-auth)

28490 (LA–3487) PROPOSAL FOR A TOROIDAL THETA-PINCH (SCYLLAC). (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Mar. 1966. Contract W-7405-eng-36. 175p. Dep. mn. CFSTI $5.00 cy, $1.00 mn.

The Scylla theta-pinch program initiated in 1957 has developed into the present Scylla IV experiment, utilizing 3.5-MJ energy storage, and producing a plasma of density 2 × 10^{16} ions/cm^3, electron temperature 300 ev, and mean ion energy 3 to 8 kev. Loss of plasma from the ends of the system limits plasma confinement of the system to a few microseconds in the present experiments. A proposed new theta-pinch experiment (Scyllac) in closed toroidal geometry will eliminate end losses. It is, however, necessary to add additional longitudinal windings to stabilize the plasma against the radial outward drift introduced in toroidal geometry. The theoretical stability of the toroidal

plasma geometry is examined. The existence of equilibrium of a toroidal plasma column is considered, and its theoretical stability examined in both the low- and high-β limits, including the possibility of dynamic stabilization. Detailed engineering design features are discussed and cost estimates are given. (auth)

28491 (MATT-Q–22) ANNUAL REPORT [ON PLASMA PHYSICS], JANUARY 1–DECEMBER 31, 1964. (Princeton Univ., N. J. Plasma Physics Lab.). Apr. 1965. Contract AT(30-1)-1238. 406p. Dep. mn. CFSTI $7.06 cy, $1.75 mn.

Research progress is reported in four sections. Separate abstracts were prepared for each section. (J.R.D.)

For abstracts of individual sections see: 28492–28495.

28492 (MATT-Q–22, pp 1-111) RESEARCH WITH THE MODEL C STELLARATOR. (Princeton Univ., N. J. Plasma Physics Lab.).

Information is presented concerning Stellarator modifications, generation of ion cyclotron waves, plasma heating, cooling time for Stellarator hot-ions, nonresonant coupling of ion cyclotron resonance heating (ICRH) power to plasmas, absorption of ion cyclotron waves. Stellarator particle losses, computer descriptions of Stellarator He discharges, Stellarator ohmic heating fluctuations, Stellarator ion and electron energies, microwave-induced discharges, plasma confinement in Stellarator discharges, effects of time-varying magnetic fields on toroidal discharges, and microwave absorption in hot plasma. (J.R.D.)

28493 (MATT-Q–22, pp 113-214) EXPERIMENTAL RESEARCH WITH SMALL DEVICES. (Princeton Univ., N. J. Plasma Physics Lab.).

Research progress is reported on Cs plasma diffusion in magnetic fields, plasma loss from cesium devices, plasma losses from Q devices, Cs plasma reactions with variably curved magnetic fields, microwave plasma heating, electron contributions to ion acoustic waves, plasma instabilities, plasma microwave emission, Cs plasma electron cyclotron heating, properties of Ba plasma, instability in etude Stellarator, electrostatic probe diagnostics, electric field D ionization, plasma rotation in B-3 Stellarator, plasma heating at 500 MHz, ion trapping in magnetic beaches, and Zeeman effect in ionized He. (J.R.D.)

28494 (MATT-Q-22, pp 215-319) THEORY. Princeton Univ., N. J. Plasma Physics Lab.).

Theoretical research is reported on negative V'' Stellarators. Information is included on a general method of investigating rotational transform systems and closed line systems. An investigation of the zero resistivity stability of negative V'' systems to trial interchange in regional lines most prone to instability is described. Information on the general stability theory is presented in which the energy principle for hydromagnetic instability is analyzed. Information is included on resistive instabilities in diffuse linear pinches, resistive overstabilities, plasma confinement and heating, kinetic theory, radiation, and plasma oscillations. (J.R.D.)

28495 (MATT-Q–22, pp 321-85) SPECIAL PROGRAMS IN PHYSICS AND ENGINEERING. (Princeton Univ., N. J. Plasma Physics Lab.).

Research and development progress is reported on atomic beam plasma temperature measurement, r-f generator for Stellarator magnetic pumping, pyrolysis and radiolysis of molten $LiNO_3$, improved stabilizing windings for magnets, production of curved magnetic fields, computerized magnetic field design, magnetometer for hot plasma control, waveguide mounts, nonreflective coatings, W fatigue in magnetic fields, brazing hollow Cu conductors, refraction devices, surface ionization, and Stellarator data handling systems. (J.R.D.)

28496 (NP-16007) OB ANOMALIYAKH UKHODA PLOTNOI PLAZMY IZ PROBKOTRONA IZ-ZA NALICHIYA, "KONYSA POTER." (On Anomalous Instability of Plasma in Probkotron Due to the Presence of "Loss-Cone"). Galeev, A. A. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). 1966. 10p. Dep. mn.

The development of instabilities, bound to the presence of a "loss-cone" in the distribution of ions according to the velocity in the Probkotron, leads to an increase of the transverse energy remaining in the ion trap with constant longitudinal energy. The stability of such anisotropic distribution of the plasma was investigated according to the velocity of the cutting out of the loss cone. The convective character of the instabilities leads to the conditions along the system in which their development is possible. (tr-auth)

28497 (TID–22956, pp 55-147) PLASMA DYNAMICS. (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics).

Research progress is reported on plasma physics, gaseous electronics, active plasma systems for controlled fusion, plasma fusion physics, liquid energy converters, alkali-metal magnetohydrodynamic generators, r-f emission from hot plasmas, incoherent light scattering from plasma, nonadiabatic trapping in toroidal geometry, and nonadiabatic scattering in magnetic fields. (J.R.D.)

28498 END EFFECTS IN A STEADY-STATE MAGNETOHYDRODYNAMIC J x B ACCELERATOR. Tempelmeyer, K. E. (ARO, Inc., Arnold Air Force Station, Tenn.). Contract AF40(600)-1200. AIAA (Amer. Inst. Aeron. Astronaut.) J., 4: 723-5(Apr. 1966).

Experimental results are presented which indirectly indicate that end effect losses are not significant in a steady-state near-atmospheric pressure J × B accelerator, which operates with much weaker magnetic field gradients and a lower conductivity level than accelerators previously described (AIAA J., 3: 115-21(1965)). (B.G.D.)

28499 CONTINUUM RADIATION FROM PARTIALLY IONIZED ARGON. Barzelay, Martin E. (Syracuse Univ., N. Y.). AIAA (Amer. Inst. Aeron. Astronaut.) J., 4: 815-22 (May 1966).

Experimental measurements of the total thermal radiation from an argon plasma arc of the wall-stabilized type with Poiseuille flow are compared with theoretical predictions. The magnitude of radiation is of importance both for re-entry calculations and use in the Heller-Elenbaas energy balance equation when transport properties are to be determined. The experimentally measured radiation (utilizing a carefully calibrated novel radiation meter) has been compared with predictions from semiclassical quantum theory (cum-experimental constants) based on recombination and bremsstrahlung. A simple equation for the total radiated power (in watts per cubic centimeter) as a function of temperature has been developed and corroborated by experiment. Spectrographically determined temperature distributions from a similar arc in the same laboratory were utilized in making the comparisons. The plasma arc was operated at 1 atm over a range of argon flow rates from 0.02 to 0.415 g/sec and currents from 35 to 500 amp for three different column lengths. Steady-state total radiation as high as 5500 w/cm of column length, representing over 30% of the power input to the arc, was measured. (auth)

28500 RADIATION FROM A LOW-DENSITY PLASMA AT 10^6 DEG TO 10^8 DEG K. Tucker, W. H.; Gould, R. J. (Univ. of California, San Diego, La Jolla). Astrophys. J., 144: 244-58(Apr. 1966).

The emission from a hot, low-density plasma due to bremsstrahlung, radiative recombination, and electron collision-induced line emission is calculated. Results are given for the total energy emission rate as a function of temperature and also for the emission in the region 2–8 Å, which is the principal region of sensitivity for the detectors in the recent x ray rocket experiments. The emission spectrum from such an optically thin plasma at $10^{7°}$K is given. This spectrum has a number of strong emission lines. If the observed cosmic x ray sources are actually hot, low-density gases, as is believed by many, these lines should be detectable. (auth)

28501 CONVECTIVE EFFECTS IN PLASMA BEAM SYSTEMS. Mikhailovskii, A. B. At. Energ. (USSR), 20: 103-6(Feb. 1966). (In Russian).

A brief review is given of the instability of plasmas for the evolution of which both the presence of directional motion of the particles and transverse inhomogeneity of their distribution functions appear necessary. The effect of the convection of charge across the interfering electric and primary magnetic fields appears to be the basis of the mechanism of the instabilities examined. The perturbing vector of unstable oscillations extends almost across the magnetic field as a result of which a motion of the ions plays an important role. As the result of interactions with such oscillations, the ions can be obtained from the beam with a large portion of their energy. It is possible to explain with this the experimentally detected effect of substantial heating of the ions by passage of the space-limited electron beam through the plasma. (tr-auth)

28502 EFFECT OF FINITE CONDUCTIVITY OF METAL ON EQUILIBRIUM OF THE PLASMA COLUMN IN TOKAMAK. Bazhanova, A. E.; Strelkov, V. S.; Shafranov, V. D. At. Energ. (USSR), 20: 146-8(Feb. 1966). (In Russian).

The effects of the finite conductivity of the metal walls on the stability of the plasma column in the Tokamak device were studied as a function of the transverse magnetic field, the radius of the plasma column, and the plasma temperature. (D.C.W.)

28503 EFFECT OF PLASMA CONCENTRATION ON SPECTROMETRIC ANALYSIS OF ELECTRON TEMPERATURES. Vdovin, V. L.; Podgornyi, I. M.; Rusanov, V. D. At. Energ. (USSR), 20: 148-9(Feb. 1966). (In Russian).

Measurements of the electron temperature in a plasma were made using both a Fabry-Perot interferometer and an electric probe. It was concluded that the electron density does not affect the spectrometric determination of the electron temperature. (D.C.W.)

28504 RECORDING OF HYDROGEN ION STREAMS WITH SEMICONDUCTOR RADIATION DETECTORS. Brevnov, N. N.; Maksimov, Yu. S.; Tsyplenkov, V. S. At. Energ. (USSR), 20: 149-51(Feb. 1966). (In Russian).

Single crystals of silicon with high resistance were used in semiconductor detectors to detect hydrogen ions streaming from an adiabatically compressed plasma. (D.C.W.)

28505 QUASI-LINEAR THEORY OF TRANSVERSE PLASMA INSTABILITIES WITH APPLICATIONS TO HYDROMAGNETIC EMISSIONS FROM THE MAGNETOSPHERE. Watanabe, Tomiya (Univ. of British Columbia, Can.). Can. J. Phys., 44: 815-35(Apr. 1966).

Transverse instabilities in two magnetoactive plasma streams are investigated theoretically. The approach taken is to investigate how a small signal transverse electromagnetic wave, which, in a zero temperature background plasma, can be propagated as a circularly polarized sinusoidal wave (with the two possible modes, electron and ion cyclotron) along the external magnetic field, behaves under perturbations arising from the existence of the streaming plasma and the nonlinear terms in the Boltzmann equations describing the plasma particle distribution. The perturbation method originally given by Bogoliuboff et al. and since developed into the so-called multiple time-scale method by Frieman et al. (1963) is employed to solve the problem. The cyclotron instability is rediscovered as the effect of the lowest order (viz., the most effective) among all possible instability processes. The wave amplitude is found to grow gradually with time in the vicinity of the cyclotron resonance frequency because of the instability. The effective wave frequency is also found to change gradually in time. The growth rate of the signal intensity and the rate of the time change in the frequency are calculated for a case of geophysical interest, viz. the instability in the ion cyclotron mode of waves by a proton stream proposed as the generation mechanism for hydromagnetic (hereafter hm) emissions. The location of the occurrence of the instabilities is taken to be the equatorial region in the outer magnetosphere. A model is considered where the instabilities occur in the region with L value equal to about 5.6. The growth rate of the signal strength calculated with reasonable values of the geophysical parameters involved is in agreement with the observations. Calculations of the rate of the time change in the wave frequency show that the frequency is seen to increase with time, and the rate, which is of the order of 0.1 cps/minute, is comparable to that obtained from observations, showing that the process proposed for hm emissions may be correct. (auth)

28506 AXISYMMETRIC RESISTIVE INSTABILITIES IN THE HARD-CORE PINCH. Hosking, R. J.; Blackwell, J. H. (Univ. of Western Ontario, London). Can. J. Phys., 44: 1037-46(May 1966).

The hard-core pinch configuration with azimuthal equilibrium magnetic field only is considered. Provided finite conductivity is included, unstable axisymmetric modes are found. These instabilities are apparently due to nonlocalized plasma diffusion across the magnetic flux lines. On the laboratory scale, the growth rates do not appear to be significant, when the material of the conducting shell is mercury. For a hydrogen plasma shell, however, it appears that the growth rates may be of practical importance. It is found that the ratio of the current in the shell to the hard-core current has a significant effect on the "spectrum" of instabilities. This effect in part accounts for the observed relative stability of the hard-core system when there is no axial equilibrium magnetic field. (auth)

28507 DIFFRACTION BY A SLIT OF INTERMEDIATE WIDTH IN AN ANISOTROPIC PLASMA. Zitron, N. R. (Univ. of Denmark, Lyngby). Can. J. Phys., 44: 1067-78 (May 1966).

The problem of diffraction by a wide slit in a uniaxially anisotropic plasma is solved by means of a multiple-scattering technique. The principal result is the consideration of the effect of the dipole term, which is the principal contribution to the interaction in certain ranges. Numerical data obtained from the analytical results are used to discuss the effects of the various kinds of interaction, anisotropy, and slit widths on the diffraction pattern of the slit at normal incidence. (auth)

28508 NONLINEAR PLASMA OSCILLATIONS WITH TRAPPED ELECTRONS. Wang, H. S. C. (Honeywell, Inc., Denver). Can. J. Phys., 44: 1109-19(May 1966).

Propagation of stationary longitudinal waves in a hot (Maxwellian) plasma is investigated, when the wave amplitude, phase velocity, and electron temperature are such that the relativistic effect is negligible but trapped electrons must be taken into account. The treatment is based on an exact solution of the nonlinear collisionless Boltzmann equation compatible with the equilibrium electron distribution. The existence, propagation, and amplitude limit of a dimensionless periodic potential wave ψ are discussed in terms of the behavior of the first integral $Y(\psi)$ of the Poisson equation. It was found that, for $\alpha = mW^2/2\kappa T$ (W is the wave velocity) less than a critical value $\alpha_c = 0.854$, no stationary wave can exist, irrespective of its amplitude. For α slightly greater than α_c, wave propagation is limited to small amplitude and low frequency. As α is further increased, waves of progressively larger amplitude can also propagate; but their amplitude is limited when $Y(\psi)$ becomes tangent to the ψ axis at ψ_{min} because of the excessive number of electrons trapped in the wave troughs. An expression for the maximum wave amplitude as a function of α is derived and plotted. Wavelengths for different values of α and amplitude levels are computed numerically and plotted as dispersion curves. A typical example for wave form is also displayed to show the progressive distortion from pure sinusoids due to nonlinearity and the effect of trapped electrons. (auth)

28509 THE RESONANCE PROBE: EXISTENCE OF A RESONANCE OF MAXIMUM AMPLITUDE. Lepechinsky, Dimitri; Rolland, Paul (CEN, Saclay, France). Compt. Rend., Ser. B, 262: 593-4(Feb. 28, 1966). (In French).

It was previously shown theoretically that the ratio characterizing the resonance of the rectified continuous current ought to have a maximum when the thickness of the sheath is half the radius of the spherical probe. An experimental verification was made of this theory. (J.S.R.)

28510 IONIZATION OF AN IMPURITY IN A PULSED DISCHARGE IN HYDROGEN: METHOD FOR THE MEASUREMENT OF THE ELECTRON TEMPERATURE. Breton, Claude; Schwob, Jean-Louis (EURATOM-CEA, Fontenay-aux-Roses, France. CNRS, Bellevue, France). Compt. Rend., Ser. B., 262: 667-70(Mar. 7, 1966). (In French).

An analytical model describing, during a pulsed discharge, the successive phases of the ionization of an impurity introduced in a low proportion in hydrogen is presented. The model takes into consideration the evolution of the intensity of the spectral lines of the successive ions. A method for the measurement of the electron temperature is deduced. (auth)

28511 OBSERVATION OF MAGNETOACOUSTIC SHOCK WAVES IN A HIGH-FREQUENCY MAGNETIC INDUCTION PLASMA. Nguyen Van Trong (Institut de Physique, Chatillon, France). Compt. Rend., Ser. B., 262: 756-7 (Mar. 14, 1966). (In French).

Relaxation waves were observed in plasma when the continuous magnetic field superposed on the h-f magnetic field passed a certain critical field. The characteristics of these relaxation waves were determined. It was concluded that the results observed could be explained by assuming that the diameter of the plasma column varies as a function of time. (J.S.R.)

28512 NONLINEAR INTERACTION OF THE ELECTROMAGNETIC WAVES IN A HOMOGENEOUS AND ANISOTROPIC LORENTZ PLASMA. Basu, Diptendu (Groupe de Recherches Ionospheriques, Saint-Maur-des-Fosses, France); Jancel, Raymond; Kahan, Theo. Compt. Rend., Ser. B, 262: 877-80(Mar. 28, 1966). (In French).

A general method is proposed for the calculation of the effects of nonlinear interaction between two modulated electromagnetic waves being propagated in a homogeneous and anisotropic Lorentz plasma. (tr-auth)

28513 COMPARISON BETWEEN TWO MEASUREMENT TECHNIQUES ON A PLASMA IN RAPID EXPANSION. Fabre, Edouard; Vasseur, Pierre (Ecole Polytechnique, Paris). Compt. Rend., Ser. B, 262: 923-5(Apr. 4, 1966). (In French).

The electron density in an expanding plasma produced by the concentration of the light energy emitted by a laser on a solid target was measured using electrostatic probes. The results were compared with measurements made with a microwave interferometer. (J.S.R.)

28514 THE RESONANCE PROBE. EXPERIMENTAL STUDY OF NON-COLLISIONAL DAMPINGS. Lepechinsky, Dimitri; Rolland, Paul (Centre d'Etudes Nucleaires, Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. B, 262: 926-8(Apr. 4, 1966). (In French).

The amplitude of the resonance peaks is limited principally by noncollisional damping as theory predicts. (tr-auth)

28515 CHARACTERISTICS OF THE METALLIC PLASMA ACCUMULATED BETWEEN TWO HIGH-FREQUENCY ACCELERATING STRUCTURES. Consoli, Terenzio; Dupas, Lucien; Leroy, Jean; Parlange, Francois; Zilli, Enrico (Centre d'Etudes Nucleaires, Saclay Gif-sur-Yvette, France). Compt. Rend., Ser, B, 262: 929-32 (Apr. 4, 1966). (In French).

The measurement of the density and energy of the particles of a metallic plasma ($\omega_p \gg \omega_{h\text{-}f}$) accumulated between two damped high frequency accelerators with progressive fields placed at the mirrors of a magnetic bottle are described. (tr-auth)

28516 ELECTRICAL CONDUCTIVITY OF A TURBULENT PLASMA. Kato, Kiyoe; Ogawa, Kiyoshi; Kiyama, Satoru; Shimahara, Hiroko. Denki Shikensho Iho, 29: 933-7(1965). (In Japanese).

Measurements were made of the electric conductivity of a plasma. The experimental tube contains an oxide-coated cathode and the mercury drops, and provides a quiescent diffusion plasma 40-cm long at a pressure of approximately 1 μHg. In order to exclude the sheath effect, the electric conductivity of the plasma is estimated from the difference of space potential between two points in the plasma. The plasma is disturbed by applying r-f voltage to the electrodes, whose frequency is selected between the plasma-electron frequency and the plasma-ion frequency and is modulated by the sine wave of 400 or 1000 c. The variation of the effective conductivity is directly displayed on a cathode ray oscilloscope by comparing the turbulent plasma with the quiescent plasma. It was confirmed by this experiment that the effective conductivity of a turbulent plasma is smaller than that of a quiescent plasma. This experimental result is qualitatively consistent with the theoretical prediction. (auth)

28517 KEMAN-EXPERIMENTAL INSTALLATION FOR A CONTINUOUS ELECTROMAGNETIC DRIVE. Au, G. F. Flugwelt, 17: 980-1(Dec. 1965). (In German).

A description of Au's continuous electromagnetic drive, which is now undergoing testing and development, and consists of a plasma generator and a radial electric and an axial magnetic field acting as a plasma accelerator is given. The device has a cylindrical copper anode and a beaker-shaped hollow copper cathode, both of which are water-cooled. The gas is led in on the left side and the accelerated plasma is ejected on the right. The electric field which exists between the cathode and the anode is approximately radial; the cathode is fed with a 400 v d-c current and the maximum power employed to date was 50 kw. Four magnetic coils surround the anode cylinder and generate an inhomogeneous magnetic field which falls off in the direction of the ejection orifice. Cesium gas is used because this element has the lowest ionization energy level. The electric flow/voltage characteristics are graphed. (Int. Aerospace Abstr.)

28518 POSSIBILITY OF DETERMINING ELECTRON CONCENTRATION AND THE MAGNETIC FIELD IN PLASMA FROM MEASUREMENTS OF THE FREQUENCIES OF DRIFT WAVES. Kovner, M. S.; Obolenskii, L. M. (Gor'kii State Univ., USSR). Geomagn. Aeronomy (USSR) (Engl. Transl.), 5: 646-9(1965).

Translated from Geomagn. Aeronomiya, 5: 831-4(1965).

Cherenkov excitation of drift waves is examined. The possibility of determining some parameters of the upper atmosphere and interplanetary space (particle concentration, magnetic field intensity, and stream velocity) from measurements of the frequencies of drift waves is discussed. (auth)

28519 COMMENTS ON "ON THE SEPARATION OF ELECTROMAGNETIC AND PLASMA MODES IN A COMPRESSIBLE PLASMA." Verma, Y. P. (Northwestern Univ., Boston). IEEE (Inst. Elec. Electron. Eng.) Trans. Antennas Propagation, AP-14: 110-11(Jan. 1966).

Some comments are made and corrections provided on the previous report by Chen and Cheng (ibid., AP-13: 651(July 1965)) in which the separation of electromagnetic and plasma modes in a compressible plasma was considered. In order to make this analysis self-consistent, the appropriate equations for a lossy compressible plasma with electromagnetic sources are presented. It appears that the previously mentioned inconsistencies resulted from the assumption that the electromagnetic parts of the fields are purely solenoidal; however, that is true only when fields are observed at a distance from the sources. (C.E.S.)

28520 SEPARATION OF ELECTROMAGNETIC AND PLASMA MODES IN A TWO-FLUID, LOSSY, COMPRESSIBLE PLASMA. Chen, H. C.; Cheng, D. K. (Syracuse Univ., N. Y.). IEEE (Inst. Elec. Electron. Eng.) Trans. Antennas Propagation, AP-14: 111-12(Jan. 1966).

A technique for separating the electromagnetic and plasma modes in a compressible plasma in which both the electrons and the ions are in motion is formulated using a two-fluid model with collision. On the basis of the general formulation, a two-fluid lossless plasma, a one-fluid plasma with losses, and a one-fluid lossless plasma are considered. (D.C.W.)

28521 CYCLOTRON HARMONIC AMPLIFICATION IN BEAMS AND PLASMAS. Crawford, F. W.; Kino, G. S. (Stanford Univ., Calif.). Int. J. Electron., Ser. 1, 19: 301-13(Oct. 1965).

Wave phenomena in electron beams and plasmas with internal motions, in the presence of a static magnetic field are considered. It is known that axially rotating beams show wave propagation when the Doppler-shifted frequency seen by the beam electrons is approximately a harmonic of the electron cyclotron frequency. Similar propagation in an infinite series of coupled modes can occur for beams and plasmas in which the electrons gyrate about the magnetic field lines, rather than the axis. Associated with each Doppler-shifted cyclotron harmonic, a slow and fast space-charge wave are propagated along an electron beam. These sets of waves can interact with each other, with slow or fast wave circuits, or with a plasma, to yield growing waves. The nature of these interactions is discussed. It is suggested that this mechanism of wave amplification along an unneutralized electron beam may provide an explanation of the noise growth observed in electron beams from shielded guns, and in crossed-field devices. (auth)

28522 BOUND WAVES IN COMPRESSIBLE PLASMA GAPS. Davis, C. (RCA Labs., Princeton, N. J.); Tamir, T. Int. J. Electron., Ser. 1, 19: 323-42(Oct. 1965).

It is shown that a planar gap in a plasma medium is an appropriate idealized model for studying electromagnetic and plasma waves in a variety of situations, including plasma sheaths and ionospheric layers. A uniform, isotropic, lossless, warm plasma gap is investigated and is found to support both surface and interface waves which consist of an electromagnetic mode coupled to a plasma pressure mode. The surface waves are fast and they occur primarily at frequencies below the plasma frequency, whereas the interface waves are slow and are present in all frequencies; in both cases, the waves may be either of the forward- or backward-traveling variety. In addition, the presence of leaky waves of the spectral type is demonstrated at frequencies above the plasma frequency. Dispersion curves are calculated for a large range of the parameters involved and the results are compared with those for surface waves along a dielectric slab which, in certain respects, represents a configuration analogous to the plasma gap if pressure effects are neglected. (auth)

28523 ELECTROMAGNETIC WAVE SCATTERING BY VELOCITY FLUCTUATIONS AND RADIATION OF FLUCTUATING MEDIA IN EXTERNAL FIELDS. Kontorovich, V. M. (Inst. of Radiophysics and Electronics, Academy of Sciences, Ukrainian SSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 8: 1244-6(1965). (In Russian).

In addition to the fluctuation-induced scattering of the dielectric or magnetic permeability, there exists also a generalized but weaker relativistic scattering mechanism directly involving the velocity fluctuations of the medium. Calculations indicate that the radiation effects occur at specific frequencies of the fluctuating systems; these effects become noticeable only at resonances at which the phase velocities of electromagnetic waves and of the excitations coincide at certain frequencies. These resonances occur for acoustic and electromagnetic waves in metals, for spin and electromagnetic waves in ferromagnetic materials, and near the resonance frequencies in plasma. The physical nature of the emitted radiation is determined by the alternating dipole moments caused by nonstationary fluctuations in external d-c fields. (TTT)

28524 ELECTROMAGNETIC WAVES GUIDED BY DIELECTRIC LAYER IN PLASMA MEDIA. Orlova, N. S. (Moscow Inst. of Power Engineering). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 8: 1246-8(1965). (In Russian).

The discrete electromagnetic spectrum created by the excitation by means of a slit of a dielectric layer in an ideally conducting plane within a homogeneous absorbing plasma is examined on the basis of its field vector potential, and the propagation constants of discrete wave types are determined. Acceleration of the excited surface waves depends on the positive or negative character of the permittivity of the external medium. The propagation constants of the surface waves above the dielectric layer in the plasma are determined without consideration of the losses; calculations indicate that the losses do not affect the character of the solution of the characteristic equations. (TTT)

28525 MAGNETOACTIVE PLASMA NONLINEAR OSCILLATIONS. Giorgadze, N. P. (Inst. of Physics, Academy of Sciences, Georgian SSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 9: 239-60(1966). (In Russian).

The nonlinear tensor of electric conductivity of a magnetoactive plasma is calculated, and the efficiency of longitudinal and transverse field generation, caused by the resonance confluence of different wave modes, is determined. General relations are used for examining the wave confluence processes in an isotropic plasma. (auth)

28526 NONLINEAR THEORY OF ELECTROMAGNETIC WAVES IN CONFINED PLASMA. Kondratenko, A. N.; Liokumovich, V. I.; Rybin, P. N. Izv. Vyssh. Ucheb. Zaved., Radiofiz., 9: 261-71(1966). (In Russian).

Electromagnetic waves in an isotropic plasma layer and in a layer in a strong constant magnetic field are considered for the case of weak nonlinearity. The second wave harmonics are found and the nonlinear dispersion equations are obtained. The phase velocity is proved to be essentially dependent on the wave amplitude in semi-bounded plasma near the critical frequency. (auth)

28527 KINETIC THEORY OF ELECTROMAGNETIC WAVE TRAVELING THROUGH PLASMA IN A MAGNETIC FIELD. Kondratenko, A. N.; Miroshnichenko, V. I. Izv. Vyssh. Ucheb. Zaved., Radiofiz., 9: 272-8(1966). (In Russian).

The reflection, transmission, and absorption coefficients are determined in the case of the normal incidence of a circularly polarized electromagnetic wave on a plane plasma layer located in a constant magnetic field perpendicular to the layer boundaries. (auth)

28528 METHOD OF WAVEGUIDE DISCRIMINATION. Il'in, S. D.; Petrusev, S. S.; Chernetskii, A. V. (Moscow Aviation Inst.). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 9: 279-86(1966). (In Russian).

A comparative evaluation of methods of u-h-f plasma diagnostics is given from the point of view of the investigation of processes associated with plasma acceleration. The transformation of phase-frequency deviations of a probing signal into the analogous voltage is examined. An expression for the band of a transforming system with a given degree of accuracy is derived. The high-speed response of the system is estimated. Considerations on the simplification of the construction of a device are given. (auth)

28529 SEPARATING DEVICE FOR MULTI-FREQUENCY UHF PLASMA PROBING. Il'in, S. D.; Petrusev, S. S.; Chernetskii, A. V. (Moscow Aviation Inst.). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 9: 287-91(1966). (In Russian).

A waveguide device is described, in which the calculated cut-off and band-Chebyshev filters are applied in a special way, permitting a subsequent separation of the frequency channels in a wide frequency range to be realized. The device may be used in space- and time-superposed multifrequency probing of plasma formations with densities of 10^{12} to 2×10^{14} electrons/cm^3. Examples of the calculation of waveguide filters and experimental results are given. (auth)

28530 ELECTROMAGNETIC WAVE AMPLIFICATION BY FLUX OF CHARGED PARTICLES IN TRANSIENT RADIATION AT SHARP BOUNDARY OF TWO MEDIA. Fainshtein, S. M. (Gor'kii State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 9: 403-4(1966). (In Russian).

An expression for the coefficient of absorption of electromagnetic waves at the sharp boundary of two plasmas at given temperature, which are penetrated by a quasineutral current of charged particles with average velocity V_0 and

temperature T_s, is found for nonrelativistic conditions and for $V_0 > v_{T_s}$, where v_{T_s} is the average thermal velocity of the particles in the current. Previously derived equations for the coefficient of absorption of plasma waves associated with transition radiation and for the plasma permittivity are used. The results show that, for sufficient velocity of the particle current, amplification of the electromagnetic waves can be obtained in this system. For a single-velocity current and a cold plasma, very efficient energy transfer from the particle current to the wave occurs. (M.J.T.)

28531 AUTO-RESONANCE ACCELERATION OF A PARTICLE IN NONHOMOGENEOUS MEDIUM. Gilinskii, I. A. (Novosibirsk State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 9: 407-10(1966). (In Russian).

The resonance acceleration of a charged particle by a circularly polarized electromagnetic wave whose field components rotate in the same direction as the particle, in a medium with a varying index of refraction n(z), is studied. Expressions for the energy and longitudinal velocity of the particle in terms of the refractive index and for the refractive index as a function of the coordinates are given. A short derivation of these expressions is presented. (M.J.T.)

28532 INTERACTIONS OF ELECTRON CURRENTS WITH SPATIAL HARMONIC FIELDS OF TWO-DIMENSIONAL PERIODIC DELAYING SYSTEMS. Dudnik, P. A. (Gor'kii State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 9: 415-17(1966). (In Russian).

A detailed formal method is used to calculate the interaction of an electron current with the fields of spatial harmonics of a two-dimensional periodic delaying system. The analysis is carried out using the example of a type-O tube with transverse interaction. (M.J.T.)

28533 METHOD OF DETECTOR CHARACTERISTICS AT AVERAGE PRESSURES. Sobol', G. A.; A. P.; Medyukh, M. M.; Galanetz, I. S. (Lvov Polytechnic Inst.). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 9: 417-19(1966). (In Russian).

A method for determining plasma potential with respect to the reference electrode, electron density, and electron temperature is substantiated on the basis of a previously derived expression for the probe characteristics for the case of particle mean free path less than probe dimensions. Formulas are developed for these plasma parameters. Probe and corresponding detector characteristics were measured simultaneously in glow- and arc-discharge plasmas in Ar, Ne, and Hg vapor, at pressures from 1.5 to 14.0 mm Hg. Graphs of the measured and calculated probe and detector volt-ampere characteristics are shown for the arc-discharge Hg plasma; deviations are due ion-current effects not taken into account in the formulas. Analogous results were obtained for the other gases and discharge types. Results of determinations of electron density and temperature in Ne and Ar plasmas are given and compared with previous experiment. (M.J.T.)

28534 TWO-PROBE METHOD FOR DETECTOR CHARACTERISTICS. Sobol', G. A.; Sobol', A. P.; Kozemchuk, R. S.; Merezhko, N. F. (Lvov Polytechnic Inst.). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 9: 419-21(1966). (In Russian).

A method is presented for determining some plasma parameters using the detector characteristics of two probes. Results of measurements and calculations of the probe and corresponding detector volt-ampere characteristics for a glow discharge in Ne at 1 mm Hg pressure are shown. Results of determining electron temperature and density in Ar and Ne are given and compared with previous results. Improvements in accuracy, speed, simplicity, and efficiency of the method presented over the method of probe characteristics are pointed out. (M.J.T.)

28535 HALL EFFECT IN A COLLISION-DOMINATED GASEOUS PLASMA. Chen, C. L. (Westinghouse Research Labs., Pittsburgh). J. Appl. Phys., 37: 2205-10 (May 1966).

A theoretical treatment of the Hall voltage developed in a gaseous plasma immersed in a uniform magnetic field is presented. The plasma considered is collision-dominated and is confined by parallel planes with insulating walls. The Hall voltage is found to depend on electron–ion volume recombination and on the tensor character of the electron mobility. The cases to be discussed are: negligible diffusion, negligible electron–ion volume recombination, and diffusion with small but not negligible volume recombination. (auth)

28536 APPLICATION OF THE VLASOV EQUATION TO THE HIGH-FREQUENCY STABILITY OF FINITE RELATIVISTIC BEAM-PLASMA SYSTEM. Dorman, G. (Polytechnic Inst. of Brooklyn). Contract Nonr 2728(00). J. Appl. Phys., 37: 2321-37(May 1966).

The response of a finite relativistic beam-plasma system to small disturbances is analyzed using the coupled Vlasov-Maxwell equations. It is shown that when $|\omega - kV_0|^2 \gg \omega_\beta^2$, where ω_β is the betatron frequency and V_0 the drift velocity of the beam, straight-line orbits are sufficiently accurate to describe the beam-particle trajectories. Dispersion relations are derived for a finite beam and for both infinite and finite plasma configurations. The effect of a finite but large beam radius is shown to increase the growth of the electrostatic instability. (auth)

28537 METHOD OF REALIZING THE MINIMUM-B FIELD. Sometani, Taro; Yamamoto, Kenzo (Nagoya Univ., Japan). J. Phys. Soc. Jap., 21: 379-84(Feb. 1966).

The minimum-B field is calculated in series of characteristic functions of Laplace's equation. It is shown that a magnetic field can be realized if the current is so distributed that the terms of higher orders in the field components are cancelled out while those of lower orders are reserved. Such current distribution can be approximately realized by using a suitable combination of current carrying conductors. (auth)

28538 NON-LINEAR HYDROMAGNETIC WAVES PROPAGATING ALONG A MAGNETIC FIELD IN A COLD COLLISION-FREE PLASMA. Kakutani, Tsunehiko (Kyoto Univ.). J. Phys. Soc. Jap., 21: 385-91(Feb. 1966).

Nonlinear hydromagnetic waves propagating along a uniform magnetic field in a cold collision-free plasma are dealt with. It is assumed that the plasma is fully ionized and quasi-neutral, and that the loop motion of the plasma particles does not occur. The solutions of the problem are divided into two classes according as l is equal to zero or not, where l is a parameter relating to the angular momentum flux carried by the plasma particles in the direction of the uniform magnetic field. In both cases, exact solutions representing wave-trains can be obtained in terms of Jacobian elliptic functions. In particular, the first class ($l = 0$) includes an isolated pulse solution as a special case. (auth)

28539 PROBLEM OF A CONDUCTING SPHERE IN STEADY-STATE PLASMA. Anastasevich, V. S. Kosm. Issled., 3: 709-17(Sept.-Oct. 1965). (In Russian).

The potential difference between a conducting sphere and a stationary, nonequilibrium plasma at infinity is calculated for the cases of no magnetic field and of a magnetic field arising from a dipole in the center of the sphere. The analysis is applied to the earth and sun treated as conducting cosmic spheres immersed in the tenuous plasma of the primary cosmic radiation. The electric field intensities in the equatorial planes of the earth and sun are calculated, assuming that the nonhomogeneous magnetic field of the cosmic objects is an effective trap for the charged particles of the plasma and that compensation of the surplus positive charge occurs by an electron current arising from displacement in collisions with ions. (M.J.T.)

28540 ALTERNATING CURRENT THROUGH A PLASMA VORTEX. Baliberdin, V. V.; Papkovich, V. G. Magnit. Gidrodin., No. 4, 24-6(1965). (In Russian).

Phenomena connected with the alternating current passing through the plasma vortex are investigated. Some theoretical suggestions are proved experimentally. The plasma vortex is formed by a pinch source with helical grooves in the inlet part of the nozzle. (auth)

28541 INVESTIGATION OF PLASMOID MOTION BY MEANS OF MICROWAVE METHODS. Markvardt, G. E. Magnit. Gidrodin., No. 4, 27-30(1965). (In Russian).

Plasmoid motion in a rail accelerator was investigated and compared with the predictions of Baranov and Musin (Radiotekhnika i elektronika, 7, 3, 547(1962)). Reflection of microwaves at the 3.2-cm wavelength was used to obtain Doppler shift, which provided continuous observation of the plasma motion. Spatial resolution of about 1 cm was achieved when observing plasma with an electron density of about 10^{12} cm^{-3}. A nonconducting barrier was inserted at the end of the plasma gun to cause the rapid deceleration of the plasma that was needed for referencing the plasmoid position. The rail accelerator and Doppler equipment are shown schematically. Both round and flat strip electrodes were used (3-cm separation). The measurements show that the plasmoid velocity initially has a large maximum which is in qualitative agreement with Baranov and Musin's predictions, where diffusion, friction, and erosion of the electrodes are taken into account. Increase of storage capacitor voltages leads to the earlier appearance of the velocity maximum. In later stages, the velocity of the plasmoid decreases owing to changes in electromagnetic forces and friction. It has also been noted that smaller velocities are achieved when flat electrodes are used. This is attributed to increased friction. (ATD)

28542 EFFECT OF A HIGH FREQUENCY FIELD ON THE TRANSVERSE PROPAGATION OF WAVES IN A MAGNETOACTIVE PLASMA. Litvak, A. G. Magnit. Gidrodin., No. 4, 31-4(1965). (In Russian).

The effect of a high frequency field of a plane electromagnetic wave on the transverse propagation of low frequency waves in a magnetoactive plasma is investigated. The problem is formulated by the use of Lorentz and Maxwell equations in addition to a continuity equation. The kinetic pressure of charged particles is not considered and hydromagnetic approximation is employed. The dispersion relationship is obtained and plotted for comparison of the case where a high-frequency plane wave is present in the plasma and where no wave is present. The dispersion curves have two branches (magnetoacoustic and extraordinary) both of which characterize instabilities when certain criteria are satisfied. The unstable region increases with the increase of the amplitude of the high frequency field. The dispersion relation obtained here is not valid near the resonance. (ATD)

28543 DISTRIBUTION OF CONCENTRATION IN THE CROSS SECTION OF CONFINED NON-EQUILIBRIUM PLASMA. Ul'yanov, K. N. Magnit. Gidrodin., No. 4, 45-9(1965). (In Russian).

The distribution of electrons and normal and excited atoms in one dimension of a nonequilibrium plasma is studied. The effect of the diffusion of particles on the equilibrium is considered in addition to radiative processes. The set of equations for particle balance is simplified by recognizing that upper levels of atoms are in equilibrium with free electrons. Further simplification occurs since excited atom currents can be neglected in comparison with ground state atom and ion currents. The simplified differential equation is solved by quadratures and specific solutions are derived for two cases. One case is for a regime where collision transitions dominate and the other for a regime where all atomic states are in equilibrium with free electrons. A numerical example shows that the reabsorption of radiation decreases the effect of diffusion. It was noted that diffusion has no effect in plasmas found in MHD generators. (ATD)

28544 THERMAL RADIATION OF AN INHOMOGENEOUS PLASMA LAYER. Dolgopolov, V. V. (Physical-Technical Inst., Kharkov). Nucl. Fusion, 6: 1-5(Mar. 1966). (In Russian).

The radiation from an arbitrary inhomogeneous isotropic layer (of a plasma, for example, when the radiation frequency greatly exceeds the electron cyclotron frequency) is discussed. With the fluctuation-theory method a formula is obtained for radiation intensity that depends on the solutions of two linear homogeneous second-order differential equations whose coefficients are determined by the distributions of density and temperature in the layer. Radiation from a semi-infinite homogeneous dielectric, from a layer with a smoothly changing dielectric permeability when the geometrical-optics method is applied; and from a layer with a smoothly changing dielectric permeability when there are regions inside the layer in which the real portion of dielectric permeability vanishes and the geometrical-optics method is inapplicable owing to the smallness of the imaginary portion is discussed. The formula for radiation intensity remains finite but exponentially small even when the imaginary portion of the dielectric permeability approaches zero. If the wave length of the radiated wave is of the order of the thickness of the inhomogeneous transparent layer inside which dielectric permeability vanishes, the radiation intensity is of the order of the radiation intensity of a black body. (auth)

28545 THEORY OF THE HYDRODYNAMIC STABILITY OF INHOMOGENEOUS PLASMA FLUXES. Lovetskii, E. E.; Rukhadze, A. A. (Lebedev Inst. of Physics, Moscow). Nucl. Fusion, 6: 9-14(Mar. 1966). (In Russian).

The stability of a multicomponent flow of cold inhomogeneous plasma with respect to conservative electromagnetic oscillations is investigated in two-fluid hydrodynamics. It is shown that, when there is a strong external axial magnetic field parallel to the plasma flux, the inhomogeneous plasma may be unstable with respect to short-wave oscillations described by the methods of geometrical optics. When there is no external magnetic field only long-wave oscillations, for whose description geometrical optics cannot be employed, are unstable; short-wave oscillations are unstable even when there is a magnetic field. The instabilities considered can develop when there is no beam instability in the plasma, and long-wave instability is possible even in a currentless plasma (plasma jet). The long-wave instability is by its nature analogous to the Rayleigh flow instability of an ideal fluid with an inhomogeneous velocity profile. (auth)

28546 COLLISION DAMPING OF TRANSVERSE ELECTRON PLASMA OSCILLATIONS. Jain, R. K. (Univ. of Delhi). Nucl. Fusion, 6: 15-17(Mar. 1966).

The effect of collisions on the transverse plasma oscillations was studied by using a relaxation model for the collision term. With the Fourier-Laplace transform method, a general dispersion relation for the oscillations of an infinite uniform plasma has been derived. (B.G.D.)

28547 TURBULENCE OF INHOMOGENEOUS PLASMA IN A STRONG MAGNETIC FIELD. Vaclavik, J. (Inst. of Plasma Physics, Prague). Nucl. Fusion, 6: 18-23 (Mar. 1966).

A study is presented of plasma turbulence arising from magnetohydrodynamic drift instability. It deals with the derivation of equations of strong plasma turbulence from equations of two-component magnetohydrodynamics by using a diagram technique. Based on these equations an estimate is carried out of the maximum value of the distribution function of the electric fields of the oscillations and the coefficient of turbulent plasma diffusion. For a more exact determination of these values and the shape of the distribution function, it is necessary to solve the system of equations numerically; therefore the system is transformed into a dimensionless form so that automatic computers can be applied. (auth)

28548 INSTABILITY OF A HOT-CATHODE DISCHARGE IN A MAGNETIC FIELD AT LOW PRESSURES. Vlasov, M. A.; Dobrokhotov, E. I.; Zharinov, A. V. (Academy of Sciences, Moscow). Nucl. Fusion, 6: 24-34(Mar. 1966). (In Russian).

Results of the investigation of an incandescent-cathode discharge in an equipotential volume in a magnetic field of 2000 Oe is presented. In the pressure range studied, 2×10^{-6} to 10^{-4} torr, there is formed a plasma column negatively charged in relation to the surrounding walls. It is

established that, when the pressure of the neutral gas is increased, such a discharge becomes unstable. A plasma torch is formed which rotates steadily in the direction of the electrons and escapes from the region of the primary electron beam. The torch is a result of plasma polarization in the primary electron beam when there is azimuthal nonuniformity of density and a difference between the ion and electron drift velocities. If the pressure is increased further the steady rotation vanishes and intensive oscillations with a continuous frequency spectrum develop in the discharge. The fundamental principles underlying this discharge behavior are explained. By means of a simplified model an expression for the rotation frequency of the torch is obtained and confirmed qualitatively by experiment. (auth)

28549 PROBING A PLASMA BY ELECTROMAGNETIC WAVES. Dnestrovskii, Yu. N.; Kostomarov, D. P. (Lomonosov State Univ., Moscow). Nucl. Fusion, 6: 35-40(Mar. 1966). (In Russian).

The problem of determining the spatial density distribution of a magnetized plasma containing cold electrons by using the measured phase difference between the incident and reflected waves in a given frequency range is examined. With the methods of geometrical optics the problem yields Volterra's integral equations of the first kind. If the external magnetic field is homogeneous the equations are linear; otherwise they are nonlinear. The equations are studied by numerical methods. The absorption of electromagnetic waves in relation to the problem of probing a plasma is also considered. (auth)

28550 PRE-IONIZATION AND SHOCK WAVE IONIZATION IN A CROSSED-FIELD PLASMA SOURCE. Brand, G. F.; Chung, S. K.; Robinson, L. C. (Univ. of Sydney). Nucl. Fusion, 6: 41-5(Mar. 1966).

An experimental investigation into the development of ionization in a cylindrical crossed-field plasma source is described. The observations are based mainly on microwave diagnostic methods; 35 Gc/sec interferometry is supplemented by measurements of the reflection of 10 Gc/sec waves from the plasma surface, enabling observations far above the density range normally accessible to microwave methods. We find that there are two stages of ionization. For the first, or pre-ionization stage, measured values of the density under various preparation conditions are presented, and estimated values of collision frequency are used for the calculation of the conductivity of the pre-ionized gas. Observations are made of the second stage of ionization, wherein a supersonic ionization front propagates through the pre-ionized gas raising it to a highly ionized state. Front velocities are measured for various pressures, magnetic induction fields and currents. Microwave reflections are used to monitor the build-up of ionization following the arrival of the ionization front at the end of the plasma vessel. (auth)

28551 INTERACTION OF FAST PLASMOIDS WITH MAGNETIC FIELD BARRIERS. Chwaszczewski, S. (Inst. of Nuclear Research, Swierk, Poland). Nucl. Fusion, 6: 56-63(Mar. 1966). (In Russian).

A useful way of obtaining more accurate information about the processes that occur when fast plasmoids are trapped in magnetic traps is to investigate the interaction of the fast plasmoids with the barriers of magnetic fields that are constant or variable in time. The results obtained may be valuable in helping to clarify questions concerning the acceleration of plasmoids by variable magnetic fields and to explain some of the processes involved in penetration of the magnetic field by the plasma. To investigate the effects of the interaction between fast plasmoids and magnetic field barriers a coaxial plasma gun of the Marshall type was constructed. When the optimum conditions for operating the gun had been established plasmoids with a speed of 1.3×10^7 cm/s and an initial density of 2.5×10^{13} ion pairs per cm^3 were obtained. During investigation of plasmoid interaction with the barrier of a constant magnetic field, compression of the plasma was observed at low field intensities. At high magnetic field intensities the density of the plasmoids penetrating the barrier decreased until the plasma was completely reflected by the barrier. Using the model of a collisionless plasma, equations were obtained for the distribution of electromagnetic fields along the radius of a plasmoid passing through the barrier. By comparing the solution of this equation with the measured diamagnetic signal the electron gas density in the plasmoid was determined; it was found to be in agreement with results obtained with a twin probe. The interaction of plasmoids with the barrier of a variable magnetic field is determined not only by the amplitude of the field intensity, but also by a whole set of interaction phases. New values characterizing these phases were introduced for convenience. The reflection, partial penetration and acceleration of the plasmoids were measured for different interaction parameters. (auth)

28552 POLARIZED PYROMETRIC PROBE: PRINCIPLES OF OPERATION AND MEASUREMENT OF PLASMA PARTICLE ENERGY. Bardet, R.; Geller, R. (Centre d'Etudes Nucleaires, Saclay, France). Nucl. Fusion, 6: 64-6(Mar. 1966). (In French).

The polarized pyrometric probe is a thermally insulated electrostatic probe made of tungsten or carbon. Unlike the Langmuir probe, its operating characteristic is located beyond the knees on the curve indicating ion and electron saturation. In hot, dense plasmas (where the Langmuir probe is difficult to use), the radiance of this probe, inferred from the temperature reading on the pyrometer, is compared with the product VI (voltage times current) of the characteristic. It is then easy to calculate the energy of the particles and to estimate their density. The principle underlying these measurements is explained and illustrated by two experimental applications for ions of 300 and of 1200 ev. (auth)

28553 EXTRACTION OF IONS FROM A MERCURY ARC PLASMA. Munakata, C. (Central Research Lab., Hitachi Ltd., Kokubunji, Tokyo). Nucl. Instrum. Methods, 41: 293-8(1966).

Ions and electrons are extracted from a mercury arc plasma through a hole of 0.1 cm $\phi \times 0.15$ cm on a discharge anode. The applicability of the $^3/_2$-power law to the ion(Hg^+) flow is examined. The ion current was between 0.17 and 7.4 μA and the apparent beam length was varied from 0.35-1.15 cm. While the electron beam extracted from the plasma obeys the $^3/_2$-power law fairly well, the mechanism of the ion extraction is quite different from that of the electron extraction. Between the normal plasma region and the pure ion beam, there is considered to be a transition or disturbed plasma region. The ions are emitted from the normal plasma and on passing through the transition plasma region where positive space charges are neutralized, a space charge limited ion beam is formed. Therefore, the $^3/_2$-power law can not be applied directly to the apparent ion beam from the plasma. (auth)

28554 LIGHT DIFFUSION BY ELECTRONS OF A PLASMA IN LABORATORY CONDITIONS. Watteau, J. P. Onde Elec., 46: No. 466, 62-74(Jan. 1966). (In French).

The laser, as a powerful light source, makes it possible nowadays to observe light diffused by electrons of a plasma produced within the laboratory despite the existence of a very small effective diffusion area. A simplified theoretical exposition is presented, and the diffusion of electromagnetic wave by a plasma is discussed taking into account electron-ion interactions. The principal conclusions necessary for the experimental interpretation are emphasized. The experimental devices used are described as well as the results which were obtained in various French and overseas laboratories. These results tend to show that this new diagnostic method, very real in data but difficult to operate, is now in the field of reality. (auth)

28555 LIMITS OF APPLICABILITY OF THE METHOD OF MEASURING ELECTRON TEMPERATURES BY THE RELATIVE INTENSITIES OF He I LINES. Strunnikov, V. M. Opt. Spectros. (USSR) (Engl. Transl.), 20: 1-4(Jan. 1966).

Translated from Opt. Spektros., 20: 3-9(Jan. 1966).

It is shown that the method of measuring electron temperatures by the intensity ratios of He I lines, which assumes that the intensities are proportional to the excitation cross sections of the lines, is not applicable to high plasma densities: $n_e > 10^{11} - 10^{13}$ cm^{-3}, $N_{He} > 10^{12} - 10^{15}$ cm^{-3}. For electron densities greater than these by two orders of magnitude the emission of the same lines is determined by the Boltzmann law with a temperature equal to T_e. A possible explanation is given for the discrepancies between measurements of T_e by different methods in experiments on high-temperature plasmas. (auth)

28556 AFTERGLOW OF HELIUM IN THE PLASMA OF A HIGH-FREQUENCY PULSE DISCHARGE AT 77 DEG K. Pakhomov, P. L.; Reznikov, G. P.; Fugol, I. Ya. Opt. Spectros. (USSR) (Engl. Transl.), 20: 5-10(Jan. 1966).

Translated from Opt. Spektros., 20: 10-20(Jan. 1966).

The mechanism of the intense afterglow of a high frequency discharge in helium at low temperatures is studied. Experimental studies of the decay of the 2^3S metastable state of helium and the afterglow kinetics of the plasma at 77°K are described. (auth)

28557 SHIFT OF Ar I SPECTRAL LINES IN THE PLASMA OF A LOW-POWER SPARK DISCHARGE. Iova, Yanku (Univ. of Bucharest). Opt. Spectros. (USSR) (Engl. Transl.), 20: 13-14(Jan. 1966).

Translated from Opt. Spektros., 20: 27-9(Jan. 1966).

On the basis of recent theories on the broadening and shifting of spectral lines and to the characterization of plasmas by means of these effects, the shift of atomic argon lines in a low-power spark discharge at pressures above atmospheric is studied. (B.G.D.)

28558 INSTABILITY OF AN ALFVEN WAVE IN A CURRENT-CARRYING COLLISION-DOMINATED PLASMA. Klozenberg, J. P. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Phys. Lett., 21: 34-5(Apr. 15, 1966).

A geometrical condition is obtained for the instability of Alfvén waves in a current-carrying plasma where ion motion is dominated by collisions and electrons spiral freely. The group velocity is found and a physical description of the instability is given. (auth)

28559 GRADIENT INSTABILITY IN THE ABSENCE OF THE MAGNETIC FIELD. Gurevich, L. E.; Ioffe, I. V. Phys. Lett., 21: 44-5(Apr. 15, 1966).

The gradient instability in the absence of the magnetic field is considered. The critical point and the frequency of the oscillations are established. (auth)

28560 HYBRID ION-ELECTRON RESONANCE FREQUENCIES IN FINITE PLASMAS. Mills, G. S.; Oakes, M. E.; Schlueter, H. (Univ. of Texas, Austin). Phys. Lett., 21: 45-7(Apr. 15, 1966). (TID-22816).

The shifts of the hybrid ion-electron resonance frequency to values above the geometrical mean of ion and electron cyclotron frequencies due to the finite length of plasmas are computed and corroborated by observations. (auth)

28561 MEASUREMENT OF PLASMA OF VERY LOW DENSITY WITH AN OPTICALLY FOCUSING FABRY-PEROT INTERFEROMETER OF 2.2-mm WAVELENGTH. Bize, D.; Cadart, M.; Cesari, C.; Consoli, T. (Centre d'Etudes Nucleaires, Saclay, France). Phys. Lett., 21: 166-7(May 1, 1966).

The properties of the interferometer, including diffraction point area, resolution power, and overvoltage coefficient, are summarized. Results of interferometer measurements of the variation of electron density and index of the plasma in a cold-cathode commercial fluorescent tube as functions of the discharge current are shown. Studies were made of a plasma column with brush-type cold cathodes, confined in a pyrex tube and able to operate either as a positive column or as a reflex discharge in Ar. Results of the global electron density measured using the interferometer and of the electron density at the center of the column measured using a Langmuir probe and calculated taking account of the radial distribution determined with the Langmuir probe are compared. (M.J.T.)

28562 ELECTRON CYCLOTRON ECHOES FROM PLASMAS. Crawford, F. W.; Harp, R. S. (Stanford Univ., Calif.). Phys. Lett., 21: 292-3(May 15, 1966).

The major features of two- and three-pulse echoes can be predicted by taking account of electron/neutral momentum scattering collisions. (auth)

28563 ACOUSTIC WAVE GENERATION AND AMPLIFICATION IN A PLASMA. Ingard, Uno (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 145: 41-6(May 6, 1966).

Acoustic wave generation resulting from the heating of neutral-gas component by the electrons in a weakly ionized plasma is analyzed. It is shown that under certain conditions wave amplification will result, and criteria for amplication and for spontaneous excitation of normal modes are derived. The results are used to explain sound emission in traveling striations in a glow discharge and acoustic modulation of a plasma afterglow. Recently reported experimental observations of acoustical effects in discharges are discussed in the light of the present analysis. (auth)

28564 OBSERVATION OF MICROWAVE SCATTERING FROM LARGE-AMPLITUDE OSCILLATIONS IN AN ALKALI PLASMA. Iannuzzi, M. (EURATOM, Rome). Phys. Rev., 145: 81-3(May 6, 1966).

Microwave scattering was observed from large-amplitude ion waves in a Cs plasma. The ion wave frequency was 24 kHz. The density fluctuations were 10% of the plasma density, which was approximately 4×10^9 cm^{-3}. An "average" cross section was obtained for the observed scattering. The result is of the order of 10^{-14} cm^2. Such a large value of the cross section is due to the high level of excitation of the ion wave. In the present experiment nonlinear effects play an important role. (auth)

28565 MAGNETO-KERR EFFECT AT A PLASMA SURFACE. Robinson, L. C. (Univ. of Sydney). Phys. Rev., 145: 91-2(May 6, 1966).

Reflection at an anisotropic plasma surface changes the polarization of an electromagnetic wave from linear to elliptical. This magneto-Kerr effect is calculated and detected experimentally when two orthogonal components of a reflected microwave beam are studied. (auth)

28566 MEASUREMENT OF THE ELECTRON CORRELATION SPECTRUM IN A PLASMA. Anderson, Oscar A. (Univ. of California, Livermore). Phys. Rev. Lett., 16: 978-80(May 30, 1966).

A quantitative measurement of the electron correlation spectrum for thermal equilibrium in a plasma by scattering of laser light is reported. (B.G.D.)

28567 QUANTUM KINETIC EQUATIONS FOR A MULTICOMPONENT SYSTEM OF CHARGED PARTICLES AND PHOTONS. Chappell, W. R. (Smithsonian Institution, Cambridge, Mass. Harvard Univ., Cambridge, Mass.); Brittin, W. E. Phys. Rev., 146: 75-91(June 3, 1966).

Quantum-mechanical kinetic equations are derived for a homogeneous, isotropic system of charged particles and photons. A hierarchy of equations is introduced by the use of the Wigner distribution operators and quasiphoton creation and annihilation operators. The method of Bogoliubov is used to truncate the hierarchy and to obtain kinetic equations. The resulting kinetic equations contain effects due to the processes of particle-particle scattering, particle-photon scattering, and single and double emission-absorption of photons by particles. In addition, there are terms representing shielding of the particles and photons, as well as other many-body effects. Photon self-energy corrections are also discussed. (auth)

28568 RELATIVISTIC MAGNETO-IONIC THEORY FOR DRIFTING PLASMA IN LONGITUDINAL DIRECTION. Unz, H. (Univ. of Kansas, Lawrence). Phys. Rev., 146: 92-5(June 3, 1966).

The magneto-ionic theory for drifting plasma at large drift velocities is discussed by using Einstein's special theory of relativity and the Lorentz transformation, for the case where the drift velocity, the static magnetic field, and the electromagnetic wave propagation are all in the

same longitudinal direction. It is shown that the algebraic equation thus found for the refractive index is identical with the one found previously in the first-order approximation for small drift velocities. (auth)

28569 OSCILLATIONS OF A WEAKLY IONIZED PLASMA IN A STRONG ELECTRIC FIELD. Ross, David W. (Univ. of Illinois, Urbana). Phys. Rev., 146: 178-86 (June 3, 1966).

The stability of a weakly ionized plasma in a strong electric field against the formation of longitudinal waves is investigated theoretically in the hydrodynamic limit $ql \ll 1$ where q is the wave number, and l is a relaxation length related to the mean free paths of the charge carriers. Applications of the theory to semiconductors and gases are considered. The behavior of the charge carriers in response to slowly varying disturbances is dominated by their collisions with the lattice or the neutral atoms, implying that an approximate equilibrium is maintained between the local field and the local densities, drift velocities, and effective temperatures of the carriers. The mean thermal energy or effective temperature of the electrons in the steady state depends on the magnitude of the applied field and can be much greater than the lattice or neutral-atom temperature. In general, this means that the electron mobility is also field-dependent. It is shown that this field dependence and the local equilibrium condition can lead to temperature oscillations which affect the phase velocity and damping of excitations resembling ion-acoustic waves. It is predicted that when the applied field exceeds a critical value the damping constant will change sign, and the system will become unstable. The feasibility of detecting this instability is discussed, and comparisons with other instabilities are made. (auth)

28570 IMPROVED DETERMINATION OF THE PLASMA POTENTIAL AND THE SHEATH RADIUS OF POSITIVE CYLINDRICAL AND SPHERICAL LANGMUIR-PROBES. Freudenthal, J.; Kinderdijk, H. M. J. (Rijksuniversiteit, Utrecht). Physica, 32: 158-66(Jan. 1966).

The probe current can be described by a formula from the orbital motion theory given by Langmuir. The probe current depends on the voltage difference between the probe and the plasma, the electron temperature, the probe radius and the sheath radius. On the other hand, an extension of the Langmuir formula for the space charge limited current is presented. In this extended formula the velocities of the electrons entering the sheath are accounted for. For several probe characteristics—with well-defined plasma potentials—the orbital motion formula together with the corrected space charge formula were checked. A good agreement exists. On the other hand, in the case of a probe characteristic with a badly known plasma potential, the two formulas can be used together to determine the plasma potential and the sheath radius. (auth)

28571 INFORMATION THEORY AND VARIATIONAL PROPERTIES OF A COLLISIONLESS INHOMOGENEOUS PLASMA WITH A MAGNETIC FIELD. Minardi, E.; Santini, F. (FOM-Instituut voor Plasma-Fysica, Jutphaas, Netherlands). Physica, 32: 497-512(Mar. 1966).

The equations describing the electric and magnetic fields of a collisionless one-dimensional plasma at stationary equilibrium in a box (with B parallel to the walls and E perpendicular to B) can be derived by assuming that their solutions give an extremum value to a certain functional which describes the information necessary for completely fixing the electric and magnetic properties of the physical system for a fixed value of the electric and magnetic energy. According to information theory this functional can be assumed as a definition of an entropy which describes the irreversible behavior of the collisionless plasma, also when situations very far from the statistical equilibrium are considered. Moreover, it can be shown, using this definition of the entropy, that a functional exists which characterizes the plasma equilibrium with the same formal properties as the Helmholtz function. When the absolute value of all field components has a minimum in the box, the entropy is maximum at equilibrium with respect to any perturbation, for a given electric and magnetic energy. In the special case when only an electric field exists, and for not too inhomogeneous plasmas, it is possible to establish in general, using Penrose's stability criterion, that a minimum value for the entropy in an equilibrium configuration (with fixed electrostatic energy) constitutes a sufficient condition for instability. Examples with magnetic field as the plane sheet pinch or the inhomogeneous plasma in uniform gravitational field with $B = e_z B_0(1 + \epsilon x)$ are also considered. In these examples the instability of the equilibrium is associated with a minimum of the corresponding entropy. It is also shown that the equilibrium of a neutral polytropic isothermal gas sphere confined by its own central gravitational field is associated with a maximum of the here defined entropy. (auth)

28572 STABILITY OF A PULSING PLASMA CYLINDER. Vandakurov, Yu. V. Prikl. Mat. Mekh., 30: 321-34(1966). (In Russian).

The stability of an ideally conducting cylindrical, symmetric plasma confined by a variable magnetic field was investigated; the instability of the system was considered to be similar to that existing within a heavy liquid supported by a lighter medium against gravitational forces. In order to examine the effect of periodic compressions and expansions of the plasma, the conditions required for exciting the inherent nonradial oscillations were analyzed. In the case of low-amplitude pulsations, this instability possesses a resonance character. The calculations showed that resonance-type nonradial oscillations may exist in a pulsing gravitating sphere. In the case of bond resonance, an oscillation close to the pulsation frequency may be excited; the flareup of variable stars may be due to such an effect. (TTT)

28573 APPLICABILITY OF THE ONE-DIMENSIONAL FLUX THEORY TO HALL CURRENTS. Eliseev, B. V. Prikl. Mat. Mekh., 30: 335-8(1966). (In Russian).

In the generalized Ohm's law for weakly ionized plasma, the expression $\omega\tau$(whereby ω = electron cyclotron frequency and τ = mean free path period) depends on the concentration of the neutral particles; therefore, creation of concentration gradients causes a distortion of the current line with respect to their distribution in a homogeneous medium. If the value of $\omega\tau$ is not smaller than 1, the effect of the nonhomogeneity depends strongly on the actual distribution in space. In the case of $\omega\tau > 1$, the current distribution is generally nonhomogeneous but the Hall current in the uncompressed liquid may be neglected if the path of the electrons is much shorter than the distance between them. Small density changes change the current and the one-dimensional equation cannot be used for high values of $\omega\tau$ in the case of sectionalized electrons. The effect of inhomogeneity was studied in the cases of a symmetric two-dimensional jet with a slowly changing cross section and of a subsonic laminar flow. It was found that the presence of inhomogeneity makes it necessary to introduce corrections in the one-dimensional flow equation for high values of $\omega\tau$. For the jet the correction amounts to $\epsilon^2\omega\tau$, whereby ϵ is the angle of inclination of the jet. (TTT)

28574 CALCULATION OF THE INTENSITIES OF OPTICALLY THICK LINES EMITTED BY HYDROGEN-LIKE IONS IN A STEADY-STATE PLASMA. Hearn, A. G. (Culham Lab., Abingdon, Eng.). Proc. Phys. Soc., 88: 171-91(May 1966).

The intensities of optically thick lines emitted by hydrogen-like ions in a plasma which is in a steady state were calculated for electron temperatures between 8000 and 256,000 Z^2 °K and for electron densities between 10^8 and 10^{18} Z^7 cm^{-3}, where Z is the charge of the bare nucleus. The optical thickness of the plasma, which is conveniently measured at the center of the Lyman α line, is between 0.1 and 100 for a uniform plane parallel plasma. The calculations solve the coupled equations of transfer when necessary for the first twenty levels for the absorption and stimulated emission of photons in the lines and include the processes of excitation, de-excitation and ionization by electron collision, spontaneous radiative decay, three-body recombina-

tion and radiative recombination. It is assumed that the ratio of the electron density to the bare ion density is constant through the plasma. It is also assumed that all the lines are Doppler broadened and that the plasma is optically thin for the continuum. Tables give the total intensity of the Lyman α and β lines and the Balmer α and β lines, the total power radiated in the lines from both sides of the plasma and the geometrical size of the plasma. The population density of the ground level is given when this is not very small compared with the electron density. (auth)

28575 COMMENTS ON A PAPER BY T. L. DUTT ON THE LOW-FREQUENCY DIELECTRIC CONSTANT OF A PLASMA. **Anicin, B. A. (Univ. of Sheffield, Eng.). Proc. Phys. Soc., 88: 193-4(May 1966).**

The bound-electron concept is compared with the warm-plasma theory. The two theories are found to be approximately equivalent for phenomena associated with the main resonance. As the bound-electron concept fails to predict the higher-order (Tonks-Dattner) resonances, it is suggested that the recently observed discrepancies between free-electron cold-plasma theory and experiment are due to finite temperature effects and not to elastic restoring forces. (auth)

28576 NONLINEAR GENERATION OF COMBINATION FREQUENCIES IN A PLASMA. Sodha, M. S.; Kaw, P. K. (Indian Inst. of Tech., New Delhi). Proc. Phys. Soc. (London), 88: 373-86(June 1966).

The generation of combination frequencies due to two strong uniform parallel electric fields of frequencies ω_1 and ω_2 in a homogeneous plasma is considered; it is found necessary to introduce terms containing exp $\{i(\omega_1 \pm \omega_2)t\}$ in f_0 (the symmetrical part of the distribution function f) and f_2 (the higher-order asymmetrical part appearing as the third term in a Legendre polynomial expansion of f), because their contributions to the combination frequency components of current density are appreciable. The growth of the combination frequency waves in a plasma and their appearance in the reflected waves from a plasma–free-space interface when two electromagnetic waves of frequencies ω_1 and ω_2 are propagating along the same direction (normal to the interface) was also studied. Some numerical results were presented. (auth)

28577 PROBE FOR MEASURING ION DENSITY IN SLIGHTLY IONIZED, HIGH SPEED FLOW. **de Boer, P. C. T. (Aerospace Corp., El Segundo, Calif. Graduate School of Aerospace Engineering, Ithaca, N. Y.). Rev. Sci. Instrum., 37: 775-85(June 1966).**

A probe made of a hollow glass cylinder is placed with its axis parallel to a slightly ionized, high-speed flow. Biased electrodes on the inside surface collect the ions and electrons entering the probe. The charged-particle density is obtained by dividing the collection current by the product of the probe entrance area, gas velocity, and charge per particle. In order to establish that all charged particles entering the probe are collected, it is verified that no particles are attracted by a pair of auxiliary electrodes downstream of the main ones. Proper functioning also requires negligible charged-particle production inside the probe, and furthermore that the velocity of the charged particles at the probe entrance be equal to the flow velocity. The probe was used to obtain ion-density profiles behind shock waves of Mach numbers 6 to 9 in air at initial pressures of 50 to 400 μ Hg. Ion densities measured were in the range 10^7 to 10^{10} cm^{-3}. Above this range, total collection was prevented by space charge effects. The equilibrium ion densities measured are in satisfactory agreement with theory. The values obtained for the ionization relaxation time are probably influenced by the presence of impurities. (auth)

28578 BAYARD-ALPERT ION GAGE AS CESIUM PARTIAL PRESSURE GAGE. **Burns, Jay (Northwestern Univ., Evanston, Ill.). Rev. Sci. Instrum., 37: 801-2 (June 1966).**

Three commercial Bayard-Alpert gages with Mo grids were tested for use as surface ionization gages for measuring Cs partial pressures by means of the thermal ionization of adsorbed Cs atoms. The sensitivity of the gages was determined to be 5 μamp of ion current/μ Hg of Cs partial pressure for a grid operating temperature of ~1200°C. A lower operating temperature was found to give more accurate results in the case of very low Cs partial pressures. (M.J.T.)

28579 ANOMALOUS ENERGY ABSORPTION OF AN ELECTROMAGNETIC FIELD IN A PLASMA. **Suramlishvili, G. I. (Institut Kibernetiki, Tiflis, Georgian SSR); Ponomarenko, Iu. B. Soobshch., Akad. Nauk Gruz. SSR, 40: 47-53(Oct, 1965). (In Russian).**

The effect of anomalous energy absorption of an electromagnetic wave impinging perpendicularly on the surface of a semibounded plasma is considered. An expression is obtained for the energy absorbed per unit time by a unit surface area of such a plasma. It is found that, if the amplitude of an incident wave exceeds a certain critical value, the energy losses of the wave will increase as the fifth power of the supercriticality. It is asserted that a correct qualitative dependence of the absorbed energy on the supercriticality can be obtained, if the waves which increase during the first portion of the oscillation period manage to attenuate to the thermal level during the remainder of the period. (Int. Aerospace Abstr.)

28580 PASSAGE OF FAST, CHARGED PARTICLES THROUGH A SLIGHTLY TURBULENT MAGNETOACTIVE PLASMA. **Tavdgiridze, T. L.; Tsintsadze, N. L. (Tbilisi Inst. of Physics, Academy of Sciences, Georgian SSR). Soobshch. Akad. Nauk Gruz. SSR, 41: 309-13(Feb. 1966). (In Russian).**

In the study of the problem presented by the passage of a fast charged particle through a constant magnetic field, in which high-frequency longitudinal oscillations were excited, the energy loss of an individual electron in the primary longitudinal field was obtained on the basis of the Landau–Lifshits expression concerning the work per unit time in the electric field caused by an external current. A generalized equation was derived for determining the losses which occur during passage through slightly turbulent magnetoactive plasma, allowing an estimation of the energy losses in a turbulent plasma, the turbulence of which is due to beam instability. The energy losses were estimated on the basis of the order of magnitude of the plasma-beam system, determining the maximum of the longitudinal oscillation spectrum for the passage of a low-density beam through the plasma. The losses were found to become large when the primary wave is transformed into a longitudinal wave with a much higher frequency. (TTT)

28581 SOME PROBLEMS OF PLASMA DYNAMICS. **Toader, Emil I. (Univ. of Bucharest). Studii Cercet. Fiz., 17: 1175-92(1965). (In Rumanian).**

The macroscopic properties of plasma are examined on the basis of the methods of statistical mechanics and the theory of the continuum. The first method which takes into account the microscopic and statistical aspects makes use of the Boltzmann and Maxwell equations in the kinetic theory of gases; the second one applies the hydrodynamic and electrodynamic equations to the conditions of the plasma. After showing the derivations of the hydrodynamic equations, they are extended to conditions of plasma dynamics. Diffusion, mobility and conductivity phenomena are related to the effects they induce. It is pointed out that the dynamic conductivity of Lorentz gases may be derived from the data presented: this value is of great importance for the h-f heating of plasma. (Review article, 32 references). (TTT)

28582 ACCELERATION AND CAPTURE OF ELECTRONS BY A MAGNETIC TRAP DURING ELECTRIC BREAKDOWN. **Karchevskii, A. I. Zh. Eksp. Teor. Fiz., 50: 307-14(Feb. 1966). (In Russian).**

A series of preliminary experiments on injection and compression of plasma blobs in a mirror trap is described. During strong magnetic compression (initial magnetic field strength $H_{0z} = 5/100$ gauss, final magnetic field amplitude $H_{max} = 12-15$ kgauss) of a comparatively

rarefied plasma ($n_{e0} \approx 2 \times 10^{12}$ cm^{-3}), x rays with an energy of about 10 kev were found to be radiated from the trap. Magnetic compression of another plasma occurred after a longitudinal current (flowing along the magnetic field lines) with an amplitude up to 10 kamp was sent through the plasma. In this case for a weak magnetic compression (H_{0z} = 1000/2000 gauss, H_{max} = 5–10 kgauss), penetrating x rays (W ≈ 40 kev) were emitted from the magnetic mirror during the duration of the pulsed magnetic field (~300 μsec); this radiation was not observed at small magnetic compression coefficients if no longitudinal current is excited in the plasma. It was found that no significant heating of the plasma due to flow of the longitudinal current occurs and that the x rays from the trap are due to acceleration and capture of a small number of fast electrons at the beginning of breakdown of the plasma column. The concentration of fast electrons responsible for the hard x rays is less than 0.1–1.0% of the electron density of the cold dense plasma inside or outside the magnetic mirror. (auth)

28583 LONG-WAVE ELECTRON OSCILLATIONS IN A BEAM-PLASMA SYSTEM. Nezlin, M. V.; Sapozhnikov, G. I.; Solntsev, A. M. Zh. Eksp. Teor. Fiz., 50: 349-63 (Feb, 1966). (In Russian).

Long-wave electron oscillations excited by an electron beam in a rarefied plasma in the presence of a strong longitudinal magnetic field were investigated experimentally. The plasma was produced as a result of ionization of the gas by the beam. The gas pressure ~10^{-5} mm Hg, and the plasma density was comparable with the beam density. The oscillations observed are not Langmuir oscillations. Their spectrum consists of a number of harmonics, the wavelengths of which (λ_n) obey the relation $\lambda_n = 2L/n$ (n is the harmonic number and L the beam length); the frequencies ω_n are defined by the velocity of the beam electrons (ν) and the wavelength: $\omega_n \sim k_n \nu$ where $k_n = 2\pi/\lambda_n$. It is shown that the excitation conditions of the oscillations and their spectral characteristics are in good agreement with the theory of longitudinal electron oscillations in an homogeneous beam-plasma system with restricted longitudinal and transverse dimensions. (auth)

28584 WEAK TURBULENCE IN MEDIA WITH DECAYING SPECTRUM. Zakharov, V. E. Zh. Prikl. Mekh. Tekh. Fiz., No. 4, 35-9(July-Aug. 1965). (In Russian).

The collision term in the wave kinetic equation describing weak turbulence in plasma is the sum of two components. The first component characterizes nonlinear wave damping and differs from zero when the wave-particle interactions are significant. The second component is intrinsically the collision term. It depends on the form of the spectrum in the medium and describes energy interchanges among various groups of waves. The case where the second component plays an important role in the collision term is studied. The analysis is carried out on a simple isotropic model of a medium with a dispersion law near to linear but with a positive second derivative–a decaying spectrum. An equation corresponding to a substantially nonequilibrium process and taking the collision term to zero is found. Results of the model are of general character and express significant regularities of weak turbulence in media with decaying spectra. (M.J.T.)

28585 HEATING OF A MEDIUM DUE TO JOULE DISSIPATION ENERGY. Vatazhin, A. B. Zh. Prikl. Mekh. Tekh. Fiz., No. 5, 28-33(Sept.-Oct. 1965). (In Russian).

The effect of Joule heating is studied in a plane electromagnetic accelerator. A closed form solution is obtained for a constant v and infinite time $\tau \to \infty$. For a more general solution the equations are Laplace transformed and integrated to yield hyperbolic functions which are then expanded in power series. For small times and small values of the parameter "a" the following expression is obtained for the heating rate

$$Q \approx \frac{4\vartheta_i \sqrt{\tau}}{\sqrt{\pi}} \left(1 + \frac{\alpha^2 \tau}{3}\right) + \frac{8\nu\tau \sqrt{\tau}}{3\sqrt{\pi}} \left(1 + \frac{\alpha^2 \tau}{5}\right).$$

These and the more general results are shown graphically for several values of "a". The above results are then discussed in the light of friction forces and thermal conduction in a MHD channel. It is shown that when the heat flow vector has a term proportional to the electric current the heat transfer is intensified. (ATD)

28586 ON RAYLEIGH-TAYLOR INSTABILITY IN Z PINCH. Nikulin, M. G. Zh. Prikl. Mekh. Tekh. Fiz., No. 5, 112-15(Sept.-Oct. 1965). (In Russian).

The stability of a Z-pinch is theoretically investigated. The plasma is assumed to be in the form of an infinite circular cylinder at zero pressure. A current is assumed to flow along the plasma surface in the z direction, creating an azimuthal magnetic field. Under the resulting Lorentz force the plasma accelerates towards the axis with a uniform acceleration g. An initial small displacement is assumed to exist at the plasma surface $\xi(\varphi, z, t) = (\xi_r, \xi_\varphi, \xi_z)$ at the point (φ, z); $n = e_r + n_1$. A differential momentum balance of the plasma motion along with the perturbation, under the assumption that these perturbations can be represented by exp (im + ikz), leads to a pressure balance. Further analysis of the governing equations of motion results in an instability mode for the zeta pinch. The expression given is then analyzed in some detail for two cases. The first case leads to the conclusion that the surface of the discharge is unstable for all values of m. The second case shows that the displacement of a particle along the plasma surface corresponds to a Rayleigh-Taylor instability with the instability growth time $1/\omega = t_* / (6kR_*)^{1/2} \ll t_*$. (ATD)

28587 DETERMINATION OF ELECTRON DENSITY AND TEMPERATURE IN A Xe HIGH PRESSURE PLASMA. Soemarmo Pranoto, I. Karlsruhe, Ger., Technische Hochschule, 1965. 35p. $2.00 Gmelin, AED-Diss. 65-251.

The electron density in a Xe arc was determined as a function of current density from the electron collision broadening of spectral lines. Temperatures are calculated from these data by use of Saha's equations. Temperatures increase slowly with the current and electron density is nearly proportional to current. (Gmelin Inst.)

28588 ELECTRICAL CONDUCTIVITY MEASUREMENTS IN A FARADAY ACCELERATOR. Goldstein, Raymond (Boeing Co., Seattle); Richmond, J. Kenneth; Oates, Gordon C. New York, American Inst. of Aeronautics and Astronautics, 1966, Paper 66-75, 12p., $1.00.

Results are presented of an experimental study of a potassium-seeded argon atmospheric-pressure Faraday accelerator. Electrical conductivity, with and without applied magnetic field, temperature of the electrodes, and potential distributions across the channels were measured. The channel was approximately 1 cm × 1 cm × 10 cm long and consisted of continuous Ta electrodes and BN sidewalls. Typical operating conditions were: Mach number ≈ 1.1, static temperature ≈ 2000°K, and static pressure ≈ 1 atm. The potential distributions across the channel, measured by means of Ta wires embedded in the sidewalls, show very large wall sheaths. Since the electrode temperatures are sufficiently high to give good thermionic emission, these large sheath voltage drops indicate the presence of thick boundary layers of low electrical conductivity. In the presence of a transverse magnetic field the measurements show that the boundary layers become thinner, as predicted by theory. The values of conductivity measured across the central core of the flow are compared with predictions of Kerrebrock's two-temperature theory, and the agreement between the measured and calculated values is good. It is believed that these are the first conductivity measurements to be reported on an atmospheric pressure, supersonic gas flow with applied magnetic field. (auth)

28589 MICROINSTABILITIES IN PLASMAS. Pfirsch, D. Munich, Univ., 1964. 96p. $2.00 Gmelin, AED-Diss. 64-1063.

Methods for theoretical analysis of plasma microinstabilities are reviewed. Some special cases of inhomoge-

neous plasma are treated by the method of normal oscillations. The method of neighborhood equilibria is used for plane geometry without space charges. (Gmelin Inst.)

28590 METHOD, CIRCUIT ARRANGEMENT AND DEVICE FOR THE GENERATION AND ACCELERATION OF RING-SHAPED PLASMOIDS. Koller, Alois; Michel, Alfred; Schindler, Heinrich (to Siemens-Schuckertwerke AG). German Patent 1,209,670. Jan. 27, 1966. Filed Mar. 8, 1963.

The device comprises two identical Helmholtz coils through which the same current is passed in opposite directions to generate a three-dimensional bicuspid geometry, and an auxiliary coil between these two main cusp coils. The method comprises the steps of creating the magnetic cusp field and injecting ionized gas (plasma) into the plane of the auxiliary coil simultaneously, and of using a very fast current pulse through the auxiliary coil as soon as the cusp field has attained its maximum value. (Gmelin Inst.)

Shielding

Refer also to abstracts 26611, 27126, 27348, 27523, and 27683.

28591 (DC-59-3-90) MILESTONE 12—DATA REPORT ON NEUTRON-INDUCED ACTIVATION OF X-211 TURBOMACHINERY MATERIALS. Beever, E. R.; Moteff, J.; Schumacher, M. J.; Tushar, H. J. (General Electric Co., Cincinnati, Ohio. Aircraft Nuclear Propulsion Dept.). Feb. 27, 1959. Contract AT(11-1)-171. 71p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Four activation experiments were completed in the Outside Tank Facility at Convair, Fort Worth using the GTR as a source. The four experiments were designed to yield the activation response of X-211 turbomachinery materials to different incident neutron spectra. Twelve material samples were irradiated in each experiment and in each case the foils were exposed with and without boral protection. The incident neutron spectra was fixed by irradiating the samples behind thick slabs of typical shield materials. The shield materials used were beryllium oxide (non-hydrogenous, moderating), water (hydrogenous, moderating), Boron carbide (non-hydrogenous, poison), and lithium hydride (hydrogenous, poison). Decay curves of the activity induced in the twelve material samples are shown for each of the four experiments. Incident neutron spectra data is presented for each case. (auth)

28592 (JINR-P-2633) ISSLEDOVANIE LIVNEI, OBRAZOVANNYKH ELEKTRONAMI S ENERGIEI 45, 130, 230 I 330 Mev V SVINTSE. (Investigation of Showers Produced by 45, 130, 230, and 330-Mev Electrons in Lead). Zaimidoroga, O. A.; Prokoshkin, Yu. D.; Tsupko-Sitnikov, V. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1966. 22p. Dep. mn.

Showers generated by $45 \pm 5^{-}$, $130 \pm 10^{-}$, $230 \pm 15^{-}$, and $330 \pm 20^{-}$ Mev electrons in lead were studied with a multiplate cloud chamber. Cascade curves and angular distributions of secondary electrons were obtained, the track length of showers were determined. (auth)

28593 (TID-22936) ANALYTIC AND MONTE CARLO STUDIES OF GAMMA-RAY SHADOW SHIELDING. Final Report. Steinberg, Herbert; Kelly, Martin J.; Aronson, Raphael (TRG, Inc., Syosset, N. Y.). May 31, 1961. Contract W-7405-eng-26, Subcontract No. 1494. 67p. (TRG-215-FR). Dep. mn. CFSTI $3.00 cy, $0.75 mn. For Oak Ridge National Lab., Tenn.

Analytical and Monte Carlo approaches to the problem of gamma ray shadow shielding are considered. The geometry of interest is an axially symmetric system in which the shadow shield is immersed in a low-Z neutron shielding material. A description of the Monte Carlo code, SHADOW, is included, along with results and operating instructions. (auth)

28594 FORBIDDEN REGIONS PRODUCED BY TWO PARALLEL DIPOLES. Levine, S. H.; Bhattacharjie, A.; Lepper, R. (Northrop Space Labs., Hawthorne, Calif.). Contract AF33(615)1220. AIAA (Amer. Inst. Aeron. Astronaut.) J., 4: 654-8(Apr. 1966).

The forbidden volume because of a non-axially symmetric magnetic field are considered both theoretically and experimentally by taking two spatially separate point dipoles with parallel axes. The experiment was performed with a magnetic simulator described in the text. An approximate analytical solution for the forbidden area in the equatorial plane (plane of symmetry) is obtained, and comparison with experimental results is made. (auth)

28595 DISTRIBUTION OF γ RAYS IN STRAIGHT HOLLOW CYLINDRICAL CHANNELS. Mashkovich, V. P.; Klimanov, V. A. At. Energ. (USSR), 20: 127-32(Feb. 1966). (In Russian).

The distribution of the intensity of γ radiation from disc isotropic and monodirectional sources with energies of 0.412 to 2.75 Mev was investigated along the axis of straight hollow cylindrical channels, passing through the shield. Water, concrete, and iron were investigated as shield materials. The experimental and theoretical results agree to ~15%. The distribution of the intensity of γ radiation within the shield and across the water shield, through which the straight cylindrical channel passed, was measured for disc isotropic sources. The experimental data agreed with the results calculated by the radial analysis method with a precision of ~20%. (tr-auth)

28596 YIELD AND ANGULAR DISTRIBUTION OF SECONDARY NUCLEONS FROM SHIELD SLABS BOMBARDED BY 660-Mev PROTONS. Kon'shin, V. A.; Matusevich, E. S.; Regushevskii, V. I. At. Energ. (USSR), 20: 132-7(Feb. 1966). (In Russian).

The yield and angular distribution of secondary nucleons from shield slabs composed of carbon, aluminum, nickel, and lead were measured. The number of nucleons was determined for three energy groups. The proton beam at 660 Mev decreased perpendicularly to the shield surface. The results were compared with the published data. (tr-auth)

28597 ANGULAR DISTRIBUTIONS OF NEUTRONS SCATTERED BY SHIELDS. Kramer-Ageev, E. A.; Troshin, V. S. At. Energ. (USSR), 20: 161-2(Feb. 1966). (In Russian).

The angular distributions of neutrons scattered by concrete, graphite, and water shields were measured using neutrons produced in (γ,n) reactions. (G.O.Y.)

28598 ANGULAR DISTRIBUTIONS OF ENERGY AND DOSE RATES OF NEUTRONS SCATTERED IN WATER. Shirkin, L. M. At. Energ. (USSR), 20: 162-4(Feb. 1966). (In Russian).

The angular distributions of the energy and dose rates of neutrons scattered in water were calculated using the Monte Carlo method. Unidirectional sources of 3.3 and 8.0 Mev were considered in the calculations. (D.C.W.)

28599 PROTECTION OF COSMONAUTS FROM ELECTRONS AND BREMSSTRAHLUNG RADIATION IN THE EARTH'S RADIATION BELT. Kovalev, E. E.; Osanov, D. P.; Radzievskii, G. B.; Mel'nik, A. D. Kosm. Issled., 3: 782-8(Sept.-Oct. 1965). (In Russian).

Methodological problems in calculating the shielding of cosmonauts from electron and bremsstrahlung exposure in the earth's radiation belt are considered. Among these problems is the selection of criteria for evaluating the radiation hazard and geometrical peculiarities of protective structures. A calculation is given of the shielding of a cosmonaut situated outside a spacecraft in a radiation belt. Experimental data on the depth distributions of the electron dose in materials of low atomic number are used in this calculation. The possibility of using a single dose distribution for electrons in an energy interval up to 3 Mev is demonstrated. Evaluations of tissue doses of bremsstrahlung produced by electrons in a shielding layer are also presented. (tr-auth)

28600 COMPARISON OF THE GAMMA-RAY DOSE IN AN EXPONENTIAL ATMOSPHERE CALCULATED BY THE MONTE CARLO METHOD AND THE MOMENT METHOD. Raso, Dominic J.; Woolf, Stanley (Technical Operations Research, Burlington, Mass.). Nucl. Sci. Eng., 25: 198-9(1966).

The results of Monte Carlo method and moment method calculations of the scattered dose resulting from a point isotropic 1.25-Mev gamma-ray source are shown to be in good agreement. It is concluded that Berger's analytical expression for the infinite medium may be utilized in the moment method, so long as the source-detector distance is determined in mass units along any given direction. (L.B.S.)

28601 SHIELDING MATERIAL FOR PROTECTION AGAINST NEUTRON RADIATION. Schnittler, Friedrich; Chvatal, Theodor. British Patent 1,025,100. Apr. 6, 1966. Filed Oct. 15, 1963.

A shielding material for protection against neutron radiation and secondary gamma radiation generated in the shielding material comprises a multi-layer body. One layer is a mixture of a synthetic resin with at least one member of the group consisting of lithium octoborate, lithium metaborate, substantially pure colemanite, and substantially pure pandermite. The other layer is a heavy material capable of reducing the detrimental effects of gamma rays and is one or more of the group consisting of iron, heavy spar, and heavy concrete. The shielding material may be formed into building blocks and a shielding structure constructed of the blocks set with a borate cement formed by mixing one of the inorganic substances mentioned above with the resin. (B.L.M.)

Solid State Physics

See *also* CHEMISTRY — Inorganic and Physical Chemistry
METALS, CERAMICS, AND OTHER MATERIALS — Properties and Structure

Refer also to abstracts 26923, 27344, 27597, 27864, 28059, 28163, 28471, and 28523.

28602 (BNL-952) DEFECTS IN CRYSTALS. Brookhaven Lecture Series No. 51. Dienes, G. J. (Brookhaven National Lab., Upton, N. Y.). Nov. 17, 1965. Contract AT(30-2)-Gen-16. 11p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

A discussion is presented on the role of defects in determining many physical properties and solid state processes and hence their importance in modern solid state research. A discussion is presented on the formation and nature of the simplest inherent defects, namely vacancies and interstitials. The production of defects by non-equilibrium methods such as quenching and radiation is described. (M.O.W.)

28603 (BNL-10134) THE APPLICATION OF DIRECT METHODS TO NEUTRON CRYSTALLOGRAPHY AND VICE VERSA. Hamilton, Walter C. (Brookhaven National Lab., Upton, N. Y.). [nd]. Contract AT(30-2)-Gen-16. 27p. (CONF-660218-1). Dep. mn. CFSTI $2.00 cy, $0.50 mn.

From Meeting of the American Crystallographic Assn., Austin, Tex.

A discussion is presented on applying direct methods to neutron crystallographic data. Neutron inelastic scattering studies for structure determinations are discussed. Observation of the coherent one-phonon scattering leads to a partial solution of the phase problem and also to a technique which can be used to enhance the scattering from selected portions of crystal structures. (M.O.W.)

28604 (IFA-FT-57) INFLUENCE OF THE PERPENDICULAR AND PARALLEL ANISOTROPY ON THE FERROMAGNETIC PROPERTIES OF THIN FILMS. Corciovei, A.; Costache, G. (Institutul de Fizica Atomica, Academia R. P. R., Bucharest (Romania)). 1966. 11p. Dep. mn.

A further development is presented of a previous theoretical study by Corciovei. The dependence of the spontaneous magnetization on the temperature and the number of monoatomic layers of thin films is calculated. Also, the dependence of Curie temperature vs. the number of monoatomic layers is calculated, taking into account the influence of magnetic perpendicular and parallel anisotropy. (auth)

28605 (JINR-P-2622) O ROLI VZAIMODEISTVIYA KVAZICHASTITS S FONONAMI V NECHETNO-NECHETNYKH DEFORMIROVANNYKH YADRAKH. (On the Role of Quasiparticle Interaction With Phonons in Odd-Odd Deformed Nuclei). Solov'ev, V. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 8p. Dep. mn.

The effect of quasiparticle interactions with phonons on the structure of the ground and excited states of even deformed nuclei was investigated. This interaction is shown to be of great importance in the case of odd-odd nuclei and inessential in even-even nuclei. (auth)

28606 (LA-DC-7561) LOCALIZED MOMENTS OF DILUTE Fe IN NONMAGNETIC HOST METALS. Taylor, R. Dean (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [1966]. Contract W-7405-eng-36. 19p. (CONF-660113-1). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From Moessbauer Symposium, New York.

The behavior of ^{57}Fe impurities in cubic, nonmagnetic elements when subjected to applied fields up to 62 kOe and temperatures down to 0.4°K was investigated by means of the the Moessbauer spectra. The performance of this method is discussed. (M.O.W.)

28607 (NYO-2471-21) A STUDY OF IMPERFECTIONS IN CRYSTALS. Progress Report, June 15, 1965-May 1, 1966. Sack, H. S. (Cornell Univ., Ithaca, N. Y. Dept. of Engineering Physics). Contract AT(30-1)-2471. 8p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Investigations were made on crystal imperfections by relaxation type measurements such as internal friction and dielectric dispersion. Brief summaries of research progress in the following three areas are presented: dipolar impurities in alkali halides, internal friction in plastically deformed metals, and two-photon processes in silver halides. (M.O.W.)

28608 (NYO-3408-5) ENERGY TRANSFER AND THE ROLE OF THALLIUM DIMERS IN THE NaI(Tl) SCINTILLATION PROCESS. Van Sciver, W. J. (Lehigh Univ., Bethlehem, Pa.). 1966. Contract AT(30-1)-3408. 7p. (CONF-660304-9). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From Institute of Electrical and Electronics Engineers, Scintillation and Semiconductor Counter Symposium, Washington, D. C.

The thallium dimer center, which is a pair of thallous ions occupying nearest neighbor cation sites in NaI, was found to have a decay time of less than 7 nanoseconds. Analysis of the emission spectrum of a typical NaI(Tl) scintillation crystal indicated that the dimer centers are responsible for approximately 25% of the scintillation light although only a small part of this is rapid. It is proposed that energy of excitation migrates among the monomers and between monomers and dimers as a result of thermal excitation. (auth)

28609 (NYO-3408-6) ROLE OF THE THALLIUM DIMER IN THE NaI(Tl) SCINTILLATION PROCESS. Progress Report. Van Sciver, W. J. (Lehigh Univ., Bethlehem, Pa.). Apr. 1966. Contract AT(30-1)-3408. 7p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Experimental research was concerned with (a) measurements of the optical characteristics of the thallium dimer center and (b) determination of parameters which may influence their formation, dissociation, or reorientation. Theoretical research on thallium monomer and dimer centers is described. Only brief results are given. (M.O.W.)

28610 (PRNC–84) NEUTRON-DIFFRACTION PROGRAM. Summary Progress Report No. 4, May 1965–April 1966. Kay, M. I.; Almodovar, I.; Gonzalo, J. A.; Cromer, D. T.; Okada, K. (Puerto Rico Nuclear Center, Mayaguez). Apr, 1966. Contract AT(40-1)-1833. 55p. Dep. mn. CFSTI $3.00 cy, $0.50 mn.

The results of neutron diffraction studies on copper formate tetrahydrate, alums, d-tartaric acid, and magnetic structure of ζ Pd_3Mn_2 are reported. The disordered hydrogen positions in copper formate tetrahydrate at room temperature were found and some of the properties of the antiferroelectric transition at –40°C determined. The structure including hydrogens of the three Alum (A^+B^{3+}) $(SO_4)_2 \cdot 12H_2O$ types (α,β,γ) were refined by neutron diffraction data. Special attention was given to the β Alum, Cs Al $(SO_4)_2 \cdot 12H_2O$. The structure of d-tartaric acid was refined. The hydrogen bonding scheme was unequivocally defined by the neutron data. Studies on Pd_3Mn_2 showed that the ζ phase is antiferromagnetic, and the magnetic cell is related to the tetragonal chemical cell by transformations. The magnetic moment for Mn is 4.1 ± 0.2 μ. The spins are aligned perpendicular to the c axis and the magnetization closely follows a Brillouin dependence from room temperature to the Neel point. (P.C.H.)

28611 (SLAC-Trans–40) INTENSE EMISSION OF SECONDARY ELECTRONS BY INCOMPACT LAYERS OF BaF_2. Seiler, Hellmut; Staerk, Manfred. Translated by Z. F. St-Gallay for Stanford Linear Accelerator Center, Stanford Univ., Calif., from Z. Angew. Phys., 19: 90-3 (1965). 15p. Dep. mn. JCL $1.60 fs, $0.80 mf.

Goetze's field-intensified emission of secondary electrons was investigated in reflection on incompact layers of barium fluoride flashed onto a firm copper support in an argon atmosphere under a pressure of a few millimeters of mercury. The yield of the secondary electrons emitted was measured at various energies (10 to 50 kev) of primary electrons and various collector potentials (50 to 400 v). This yield was found to increase with increasing collector potential and decreasing primary electron energy. The half-width value of the energy distribution of secondary electrons was found to increase with increasing collector potential and therefore with increasing secondary electron yield. Whereas, at a primary electron energy of 10 kev, compact barium fluoride gave a secondary electron yield of only 0.9 (half-width value 8 ev), an incompact layer of barium fluoride gave, at a collector potential of 300 v, a secondary electron yield of about 20 (half-width value 17 ev). (auth)

28612 DEEP DIFFUSIONS OF PHOSPHORUS AND CHLORINE IN SILICON UNDER NEUTRON IRRADIATION. Schmidt, Paul F. (Bell Telephone Labs., Inc., Allentown, Pa.). Appl. Phys. Lett., 8: 264-6(May 15, 1966).

Observations are reported of 20- to 30-μ-deep radiation-enhanced diffusion tails of P and Cl in p-type Si slices exposed for one week at 100 to 250°C to a flux of 1.2×10^{13} thermal and 1.5×10^{11} fast neutrons/cm²/sec. The Si slices consisted of oxidized blanks, oxidized wafers with P diffused into the oxide surface, and predeposited and diffused bare Si. Results of phosphorous concentration profiles and p-n junction movement are shown. Contamination due to radioisotopes produced in the neutron irradiation is discussed. Possible mechanisms considered to explain the increased diffusivity are excess vacancies during neutron irradiation, lattice damage due to displacement spikes, and diffusion of P by an interstitial mechanism. (M.J.T.)

28613 TWO-STEP EXCITATION IN TRIVALENT THULIUM. Esterowitz, L.; Noonan, J.; Schnitzler, A. Appl. Phys. Lett., 8: 271-3(June 1, 1966).

A two-step excitation fluorescence or infrared quantum counter action is obtained in the thulium ion. The quantum counter fluorescence terminating in an excited state was observed at room temperature. This termination is necessary (recycling of the electron) in order to achieve quantum counter gain. The guest thulium ions exhibited similar absorption and fluorescence spectra in single crystal hosts of CaF_2, SrF_2, BaF_2, CdF_2, and $CaWO_4$. (B.G.D.)

28614 ISOTOPIC EFFECTS ON THE PHONONLESS LINES OF COLOR CENTERS IN LITHIUM FLUORIDE. Durand, Pierre; Toulouse, Gerard (Univ. Paris., Orsay, France). Compt. Rend., Ser. B., 262: 714-17(Mar. 7, 1966). (In French).

Some fine lines present a significant displacement in the passage from a ^6LiF crystal to a ^7LiF crystal. This displacement was measured in absorption at 4°K for the known lines at 4747, 4874, and 6008 Å and for a new line at 5503 Å. (tr-auth)

28615 MAGNETIC PROPERTIES OF RARE EARTH CHROMITES. EXPERIMENTAL RESULTS. Aleonard, Roland; Mareschal, Jean; Pauthenet, Rene; Rebouillat, Jean-Paul; Zarubica, Vasilije (Laboratoire d'Electrostatique et de Physique du Metal, Grenoble, France). Compt. Rend., Ser. A, 262: 799-802(Mar. 21, 1966). (In French).

The rare earth chromites are antiferromagnetic. The values of the Neel temperatures of the chromite ions, the Neel temperatures of the rare earth ions, Curie paramagnetic points, and the Curie constants are indicated. The relative importance of the various magnetic interactions are deduced from these results. (tr-auth)

28616 INTERPRETATION OF THE MAGNETIC PROPERTIES OF RARE EARTH CHROMITES. Aleonard, Roland; Pauthenet, Rene; Rebouillat, Jean-Paul; Zarubica, Vasilije (Laboratoire d'Electrostatique et de Physique du Metal, Grenoble, France). Compt. Rend., Ser. B, 262: 866-9 (Mar. 28, 1966). (In French).

The rare earth chromites can be decomposed into an antiferromagnetic lattice of chromium ions and another antiferromagnetic lattice of rare earth ions; the interactions between the rare earths and chromium are very weak. The magnetic properties of various ions and chromites were studied between 2 and 1500°K in a model molecular field. (tr-auth)

28617 OBSERVATION OF IONIZED CENTERS WITH ELECTRONS IN LITHIUM FLUORIDE. Farge, Yves; Toulouse, Gerard; Lambert, Marianne (Faculte des Sciences, Orsay, France). Compt. Rend., Ser. B, 262: 1012-15(Apr. 13, 1966). (In French).

The study by emission and absorption spectroscopy of irradiated lithium fluoride crystals showed the formation of ionized centers with electrons: the bands of absorption and emission at 6450 and 9000 Å and the phononless ray at 7633 Å are attributed to the F_2^+ center, an electron associated with a double band of negative ions following a [110] direction. (tr-auth)

28618 NUCLEAR MAGNETIC RESONANCE. PART I. Ingram, D. J. E. (Univ. of Keele, Eng.). Contemp. Phys., 7: 13-28(Oct. 1965).

The principles of nuclear magnetic resonance are explained. The energy states of nuclei in magnetic fields are considered, and the resonance conditions are discussed, together with the interaction of the spin system with electromagnetic radiation. Nuclear resonance signals from the solid state are described; the reduction of line width by rotation of the crystal or molecule is then considered, as an introduction to measurements in the liquid state. (auth)

28619 NUCLEAR MAGNETIC RESONANCE. PART II. Ingram, D. J. E. (Univ. of Keele, Eng.). Contemp. Phys., 7: 103-21(Dec. 1965).

The discussion of nuclear magnetic resonance considers systems which produce narrow resonance lines. The origins of line splitting are first considered, one type due to the chemical environment and a second type due to interaction between the nuclear spins within the molecule itself. The technique of double resonance simplifies complex spectra by applying a second radiofrequency at the same time. After a brief summary of results obtained from metals and ferromagnetics, the more recent Overhauser effects are described since the effective sensitivity of nuclear resonance spectrometers can be increased by several orders of magnitude by applying microwave power at the electron reso-

nance frequency at the same time. Echo and pulse techniques and the way in which these can be applied in very low magnetic field strengths are considered. (auth)

28620 THE MAGNETIC PROPERTIES OF $YMnO_3$. Kizhaev, S. A.; Bokov, V. A.; Kachalov, O. V. (Inst. Poluprovodnikov, Leningrad). Fiz. Tverd. Tela, 8: 265-7(Jan. 1966). (In Russian).

Measurement of the magnetic susceptibility of single crystals of $YMnO_3$ was carried out from 4.2 to 300°K. The difference between $\chi_{||}$ and $\chi_{\perp}$ was not large; at 4.2°K $(\chi_{\perp} - \chi_{||})/\chi_{\perp} = 3\%$. A plot of magnetic susceptibility against temperature is illustrated; values for the Curie-Weiss law were found to be $\Theta = -700$°K, $C_{mol} = 4.15$. No spontaneous magnetic moment was observed at low temperatures; neither was the characteristic anomaly in the temperature dependence of antiferromagnetic phase transitions observed. Antiferromagnetic regulation is detected, however, at 4.2°K by neutronographic investigations, which are supported also by the large negative value of Θ and the small anisotropy of $(\chi_{\perp} - \chi_{||})$. This situation is similar to that of $Nb_2Co_4O_9$. Comparison of the relation between the Neel temperatures and the nuclear parameter (a) for several lanthanide compounds $MMnO_3$ (M = lanthanide) led to the conclusion that the temperature of the antiferromagnetic transition should lie in the region of the boiling point of N_2. (BBB)

28621 ON EXCITATION OF LOW-FREQUENCY WAVES IN A SEMICONDUCTOR PLASMA, IN CONSTANT ELECTRIC AND MAGNETIC FIELDS. Khankina, S. I.; Yakovenko, V. M. (Inst. of Radiophysics and Electronics, Academy of Sciences, Ukrainian SSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 9: 207-9(1966). (In Russian).

In previous investigations of the low-frequency electromagnetic oscillations in a semiconducting electron-hole type plasma placed in a constant electric field E_0, the energy dependence of the electron collision frequency has not been taken into account; subsequently, it was found that consideration of this dependence may result in a negative differential conductivity which could amplify the oscillations. By applying a constant magnetic field H_0 in a direction perpendicular to E_0, the normal waves are expected to become purely transversal and longitudinal ones; their oscillation spectrum and damping may be obtained on the basis of dispersion relations. The calculations carried out indicate that under certain conditions, the large-scale oscillations are extinguished with time while the fine oscillations are amplified. (TTT)

28622 PROPAGATION OF BRAGG-REFLECTED NEUTRONS IN BOUNDED MOSAIC CRYSTALS. Werner, S. A. (Ford Motor Co., Dearborn, Mich.); Arrott, Anthony; King, J. S.; Kendrick, H. J. Appl. Phys., 37: 2343-50 (May 1966).

The analysis of the multiple Bragg reflection of a neutron beam of finite size in a semi-infinite mosaic crystal given previously is generalized to include bounded crystals. The coupled differential equations describing secondary extinction given by Hamilton are solved in general, and a method of piecewise solution, or solution by regions, is given. A discussion is given of experiments of the spatial distribution of the diffracted current from slab-shaped crystals. Various methods for measuring the probability for Bragg scattering per unit path are compared and found not to agree. It is felt that the discrepancies are basic to the mosaic structure of crystals in general. (auth)

28623 PROTON-EXCITED LUMINESCENCE OF SILICATES: EXPERIMENTAL RESULTS AND LUNAR IMPLICATIONS. Nash, Douglas B. (California Inst. of Tech., Pasadena). J. Geophys. Res., 71: 2517-34(May 15, 1966).

Spectral energy distributions and excitation efficiencies as functions of mineral composition, irradiation time, proton energy, proton flux, sample geometry, and sample temperature were determined from laboratory measurements of silicate luminescence by low-energy proton excitation. The maximum of the luminescence spectra of many silicates under continuous excitation by 5-kev protons is in the red when the mineral is first excited; the luminescence intensity decreases, and the maximum shifts from red to blue with time. This phenomenon is described as a red flash. After the initial red flash, a second red flash, subsequent intensity decay, and blue shift can be produced by a sudden increase of incident ion energy. In both cases the red flash has a principal decay period of about 15 to 20 minutes. The intensity of both the flash and aged luminescence response is directly proportional to incident ion energy and flux. Small particle size for powders, high roughness for solid surfaces, and low mineral temperature favor high luminescence intensity. These data qualitatively agree with the concept of solar-ion excitation as the origin of reported transient lunar reddening near Aristarchus and Kepler. However, these measurements show that the energy efficiency for proton excitation of silicate luminescence is between 10^{-4} and 10^{-6}; this range is several orders of magnitude lower than values previously reported. In view of the known solar-ion flux, the low efficiencies indicate that luminescence on the sunlit lunar surface resulting from solar-ion excitation is far below the sensitivity of earth-based detection apparatus and that other energy sources or other explanations for the origin of lunar color flashes must be sought. (auth)

28624 MOESSBAUER ABSORPTION MEASUREMENTS IN IRON-CONTAINING MINERALS. Herzenberg, C. L.; Toms, D. (Illinois Inst. of Tech., Chicago). J. Geophys. Res., 71: 2661-77(May 15, 1966).

Mössbauer resonance absorption spectra were measured for 13 samples of natural and synthetic minerals containing iron, including oxides, oxyhydroxides, biotite, jarosite, ilmenite, and others. The spectra are analyzed for energy shifts and hyperfine splittings, and information so obtained on internal magnetic fields, electric quadrupole interaction, oxidation states, and correlation with crystal structure is presented. (auth)

28625 NUCLEAR MAGNETIC RESONANCE STUDIES OF BERYLLIUM-BASED LAVES PHASE XBe_2. Saji, Haruo; Yamadaya, Tokio; Asanuma, Mitsuru (Matsushita Research Inst. Tokyo, Inc., Kawasaki, Japan). J. Phys. Soc. Jap., 21: 255-61(Feb. 1966).

The nuclear magnetic resonance (NMR) of ^9Be was investigated with several beryllium-Laves phase intermetallic compounds $TiBe_2$, $CrBe_2$, $MnBe_2$, and $CuBe_2$ at various temperatures from 77 to 300°K. The Knight shift of ^9Be resonance was found to be constant: $(\sim -0.01\%)$ in $CrBe_2$ and $(\sim -0.06\%)$ in $MnBe_2$ at all temperatures. In $TiBe_2$ the shift of ^9Be resonance depends on temperature, and varies from (-0.08%) to (-0.04%) in the temperature range from 77 to 300°K. The NMR of ^{55}Mn in $MnBe_2$ and $^{47}Ti + {}^{49}Ti$ in $TiBe_2$ were also observed. The shift of ^{55}Mn resonance was $(\sim -0.8\%)$, which was temperature independent, while that of $^{47}Ti + {}^{49}Ti$ varied from $(\sim -0.5\%)$ to $(\sim +0.07\%)$ in the temperature range from 77 to 300°K. As for $^{47}Ti + {}^{49}Ti$ resonance, the relation between the Knight shift (K) and the susceptibility (χ) is linear. From the K vs χ curve the apparent hyperfine field can be estimated at 27 KOe/spin. This small value of hyperfine field may be considered to have resulted from a mixture of s character into the d wave functions. A simple band model is proposed to account for the NMR properties of these compounds. (auth)

28626 ANTIFERROMAGNETISM OF DISILICIDES OF HEAVY RARE EARTH METALS. Sekizawa, Kazuko; Yasukochi, Ko (Nihon Univ., Tokyo). J. Phys. Soc. Jap., 21: 274-8(Feb. 1966).

Magnetic properties of disilicides of Gd, Tb, Dy, Ho, and Er were investigated at temperatures ranging from 4.2°K to room temperature. All the disilicides except $ErSi_2$ have the orthorhombic $ThSi_2$ type of crystal structure and are shown to be antiferromagnetic. The Néel temperatures of $GdSi_2$, $TbSi_2$, $DySi_2$, and $HoSi_2$ are 27°, 17°, 17°, and 18°K, respectively. The compound $ErSi_2$ has the hexagonal AlB_2 type of crystal structure and is paramagnetic at above 4.2°K. The paramagnetic Curie temperature of these compounds decreases with the number of f electrons of the rare earth ion. (auth)

28627 ANISOTROPIC s-f INTERACTION IN RARE EARTH METALS. I. FUNDAMENTAL CONSIDERATION

BASED ON THE FREE ELECTRON MODEL. Kasuya, T. (Tokyo Univ.); Lyons, D. H. J. Phys. Soc. Jap., 21: 287-307(Feb. 1966).

General treatment of the s-f anisotropic exchange interaction is given based on the formulation of Kaplan and Lyons. The free electron model is assumed, and the results given as an expansion in $k_f\bar{r}_f$. Various types of induced f-f interactions are also obtained as an expansion in $k_f\bar{r}_f$. The range of these f-f interactions is shown to increase with the order. The contribution to the electric resistivity is also given together with the contribution from screened multipole scattering. Qualitative comparison with actual rare earth metals may be made by using a more realistic band model. (auth)

28628 MAGNETIC PROPERTIES OF $GdSi_2$. Yaguchi, Koichi (Totsuka Works Hitachi, Ltd., Yokohama, Japan). J. Phys. Soc. Jap., 21: 405(Feb. 1966).

The magnetic properties of polycrystalline $GdSi_2$ were studied. It was also confirmed that the crystal structure was a tetragonal $ThSi_2$ type. The magnetic susceptibility was measured using magnetic balance and is shown. An asymptotic Curie temperature, Curie constant, effective Bohr magneton number, and spin quantum number were also found. (J.F.P.)

28629 INFRARED LATTICE SPECTRA OF CUBIC RARE EARTH OXIDES IN THE REGION 700 TO 50 cm^{-1}. McDevitt, Neil T. (Wright-Patterson AFB, Ohio); Davidson, A. D. J. Opt. Soc. Amer., 56: 636-8(May 1966).

The infrared lattice spectra from 700 to 50 cm^{-1} of eight cubic rare earth oxides are reported. It is evident from these data that the crystal structure determines the frequency position, and clearly shows the effect of the lanthanide contraction in this series of compounds. (auth)

28630 INFLUENCE OF CRYSTAL LATTICE ON MOTION OF ENERGETIC CHARGED PARTICLES. Lindhard, Jens. Kongel. Dan. Vidensk. Selsk., Mat.-Fys. Medd., 34: No. 14, 1-64(1965).

A theoretical approach to the problems of directional effects for energetic charged particles moving through solids is presented. Some aspects of directional effects are given. The fundamental approximations of the description are stated, and the associated simple concept of a string of atoms is introduced. Basic statistical estimates in calculations of directional effects are treated. As a function of transverse energy, $E_\perp$, the slowing-down is calculated for electronic and nuclear collisions. Multiple scattering, i.e., lack of conservation of transverse energy, is studied. The normal multiple scattering, due to nuclear collisions, is strongly reduced for low values of $E_\perp$. The rate of physical processes depends on the external angle between a beam and a crystal. It is found that in simple cases the average of such rates over direction gives the same result as in a random system. Similar rules hold for spatial averages. Experiments on directional effects are discussed from a theoretical point of view, and the main effects to be taken into account are summarized. The order of magnitude of dip minima is estimated. The possibilities are discussed of using as an experimental tool the shadow belonging to e.g. strings. A few comments are made on recent experiments connected with string effects. (auth)

28631 CALCULATION OF MOESSBAUER ABSORPTION AREAS FOR THICK ABSORBERS. Hafemeister, D. W.; Shera, E. Brooks (Los Alamos Scientific Lab., N. Mex.). Nucl. Instrum. Methods, 41: 133-4(Apr. 1966). (LA-DC-7499).

The calculation of Lang (Nucl. Instr. and Meth. 24: 425 (1963)) for interpreting Mössbauer spectrum areas is extended to larger values of absorber thickness. The results are presented graphically together with values of the absorption amplitude and relative line width calculated by Roberts and Thomson (Phys. Rev., 129: 664(1963)). (auth)

28632 ANOMALOUS MAGNETIC EFFECT IN MOESSBAUER SPECTRA OF SOME Fe^{3+}-COMPOUNDS. Housley, R. M.; De Waard, H. (Univ., Groningen, Netherlands). Phys. Lett., 21: 90-2(Apr. 15, 1966).

Anomalous narrowing of Mössbauer lines of some paramagnetic Fe^{3+}-compounds was observed when transverse or longitudinal magnetic fields are applied. A longitudinal field has a stronger effect than a transverse field. (auth)

28633 LATTICE SOFTENING IN SINGLE CRYSTAL Nb_3Sn. Keller, K. R.; Hanak, J. J. Phys. Lett., 21: 263-4(May 15, 1966).

The velocity of 42 Mc/sec ultrasonic waves propagated in the [110] direction was measured in single crystal Nb_3Sn from 300 to 4.2°K. The elastic constants and stiffness parameter $(C_{11}-C_{12})/2C_{44}$ were calculated. The stiffness parameter and elastic constants exhibit a large decrease on cooling similar to those found in V_3Si. (auth)

28634 PHOTOLUMINESCENCE OF THE Z_3 CENTER IN LiF:Mg. Mort, J.; Zimmerman, D. W. (Univ. of Wisconsin, Madison). Contract AT(11-1)-1105. Phys. Lett., 21: 273-4(May 15, 1966).

Photoluminescence was observed in x-irradiated magnesium-doped LiF. A measurement of the excitation spectrum for this emission shows that it arises from the Z_3 center in this material. (auth)

28635 IMPRISONMENT OF PHONONS BY Pr^{3+} IONS IN PRASEODYMIUM ETHYLSULFATE. Griffiths, D. J.; Glaettli, H. (Univ. of British Columbia, Vancouver). Phys. Lett., 21: 275-6(May 15, 1966).

The optical Faraday rotation was used in conjunction with pulsed microwave resonance to determine the magnetic field dependence of the paramagnetic relaxation time in concentrated praseodymium ethylsufate. The results are interpreted in terms of phonon imprisonment by the praseodymium ions. (auth)

28636 NEW DEFECT CENTER IN AMMONIUM HALIDES: MOTIONAL EFFECTS. Patten, F. W. (Naval Research Lab., Washington, D. C.). Phys. Lett., 21: 277-8(May 15, 1966).

Evidence is presented for the existence of a new radio-induced paramagnetic defect center, NH_3X, in the ammonium halides, where X represents a halogen atom, which exhibits thermally activated motional effects as a result of reorientation of the NH_3^+ group. (auth)

28637 CRITICAL FIELDS FOR MAGNETIZATION REVERSAL IN YTTRIUM ORTHOFERRITE. Craik, D. J.; McIntyre, D. A. (Univ. of Nottingham, Eng.). Phys. Lett., 21: 288-9(May 15, 1966).

The coercive force of some single crystal yttrium orthoferrite specimens was found to be an increasing function of the field used to saturate the specimen, even for applied fields well above $4\pi I_s(I_s = 8.84$ emu). (auth)

28638 NEW TECHNIQUE FOR MOESSBAUER SPECTROMETRY. Bressani, T. (Univ., Cagliari, Italy. Istituto Nazionale di Fisica Nucleare, Turin); Brovetto, P.; Chiavassa, E. Phys. Lett., 21: 299-301(May 15, 1966).

A self-modulation method is applied to Mössbauer spectrometry. Some results concerning the ^{57}Fe γ ray absorption peak are given. (auth)

28639 PARAMAGNETIC RESONANCE OF DIVALENT PRASEODYMIUM IN CALCIUM FLUORIDE. Merritt, F. R.; Guggenheim, H.; Garrett, C. G. B. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 145: 188-91(May 6, 1966).

The electron paramagnetic resonance spectra of Pr^{2+} in the cubic field of CaF_2 was obtained at 24 kMc, at liquid-helium temperatures. As predicted, the measurements show that the ground state of Pr^{2+} is Γ_8. Their parameter x is estimated to be -0.55 for Pr^{2+}, which is in line with data on other ions in CaF_2. Extensive and complicated hyperfine structure was detected in addition to the fine-structure splitting of the Γ_8 state but no analysis is made of it. Since the hyperfine splitting was not small relative to the Zeeman splitting, normally forbidden $\Delta m_I = \pm 1$ transitions were also observed. (auth)

28640 INELASTIC SCATTERING CROSS SECTIONS FOR 20-kev ELECTRONS IN Al, Be, AND POLYSTYRENE. Swanson, N.; Powell, C. J. (National Bureau of

Standards, Washington, D. C.). Phys. Rev., 145: 195-208(May 6, 1966).

Measurements are reported of the inelastic scattering cross sections associated with the characteristic energy losses of 20-kev electrons transmitted through thin films of Al, Be, and polystyrene. These measurements were made using two techniques which overcome several sources of systematic error in previous measurements. For materials which have narrow characteristic loss lines (such as Al), it is possible to establish the form of the differential cross section and the generalized oscillator strength for the ≈15-ev Al plasmon energy loss for scattering angles between 0 and 20 mrad, the cutoff angle. The differential cross section was used in repeated two-dimensional folding calculations to correct the intensity measurements of the multiple plasmon losses at the larger scattering angles where unambiguous intensity measurements could not be made. For materials which have broad characteristic loss peaks, such as polystyrene, it is not possible to establish the variation of generalized oscillator strength f(q) with momentum transfer q. If it can be assumed that f(q) ≈ f(0) for small q, a cross section for a given loss can be obtained from an energy-loss spectrum measured at one scattering angle. The cross section measurement accuracy is improved by a comparison of two energy-loss spectra, that of a standard (such as Al) and that of a material of unknown loss cross section, which were obtained at zero angle under the same measurement conditions. Cross sections of $(1.5 \pm 0.4) \times 10^{-18}$ and $(1.5 \pm 0.5) \times 10^{-18}$ cm^2 were measured for the excitation of the ≈15- and ≈19-ev plasmon energy losses in Al and Be, respectively, using the former measurement technique. These values are in good agreement with the cross sections expected theoretically. The second measurement technique was used to obtain cross sections of $(2.4 \pm 0.8) \times 10^{-20}$ and $(1.0 \pm 0.2) \times 10^{-18}$ cm^2 for the 7- and 21-ev energy losses, respectively, in polystyrene. The corresponding oscillator strengths f(0) are in good agreement with those deduced recently. Values were also obtained for the Al loss-dispersion constants, $\Delta E(\theta) = 14.8 + (1.39 \pm 0.07) \times 10^4\theta^2 + (1.2 \pm 0.2) \times 10^7\theta^4$ (energy loss ΔE in ev, scattering angle θ in radians), and for the critical wave vector for plasmon excitation $k_c = 1.46 \pm 0.07$ Å^{-1}. (auth)

28641 PLASMON DAMPING IN METALS. Ninham, B. W. (Univ. of New South Wales, Kensington, Australia). Powell, C. J.; Swanson, N. Phys. Rev., 145: 209-17 (May 6, 1966).

A report is given of a theoretical and experimental investigation into the degree of plasmon damping in metals as a function of momentum transfer. A previous theoretical result is corrected and extended by taking into account polarization effects. Measurements are reported of the change in half width $\Delta E_{\frac{1}{2}}$ of the dispersed ≈15-ev aluminum plasmon energy-loss peak, excited by 20-kev electrons, as a function of electron scattering angle θ. The results can be expressed in the form $\Delta E_{\frac{1}{2}} = A + B\theta^2 + C\theta^4$, and there is good agreement between the values of B and C obtained from the revised theory and those found experimentally. (auth)

28642 DENSITY EFFECT FOR THE IONIZATION LOSS OF CHARGED PARTICLES. Sternheimer, R. M. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 145: 247-50(May 6, 1966). (BNL-9794).

The reduction in the ionization loss of charged particles due to the polarization of the medium (density effect) was evaluated for several substances. An approximate semi-empirical expression for the mean excitation potential I as a function of the atomic number Z was obtained. (auth)

28643 THEORY OF POSITRON LIFETIME IN SOLID ARGON: THE EFFECT OF CORRELATION. Woll, E. J. Jr. (Carnegie Inst. of Tech., Pittsburgh); Rose, K. L. Phys. Rev., 145: 268-73(May 6, 1966).

An approximation technique is suggested which should prove useful for calculation of correlated electron-positron wave functions in insulating solids. This technique is based on the Born-Oppenheimer method of calculating molecular properties, and is physically grounded in the idea that the Coulomb interaction between electrons and positron should affect the positron more profoundly than it does the tightly bound electrons. The technique is used to calculate, in the lowest order approximation, a wave function for solid argon showing the effects of correlation. This wave function is used to compute positron lifetime and angular distribution of annihilation radiation. The lifetime is found to be in reasonable agreement with experiment; on the other hand, the use of the lowest order wave function for calculation of the angular distribution gives results which are apparently in disagreement with experiment. (auth)

28644 SPIN-LATTICE RELAXATION IN SOME RARE-EARTH SALTS. II. ANGULAR DEPENDENCE, HYPERFINE EFFECTS, AND CROSS RELAXATION. Larson, G. H.; Jeffries, C. D. (Univ. of California, Berkeley). Phys. Rev., 145: 311-24(May 6, 1966).

In the study of the spin-lattice relaxation rate T_1^{-1} in the temperature range $1.2 \leq T \leq 5$°K of some trivalent rare-earth ions in the salts $La_2Mg_3(NO_3)_{12} \cdot 24H_2O$[LaMN], $La(C_2H_5SO_4)_3 \cdot 9H_2O$[LaES], and $Y(C_2H_5SO_4)_3 \cdot 9H_2O$[YES], the dependence of T_1^{-1} on the angle θ between the crystal symmetry axis and the magnetic field H. Data are obtained from the transient recovery of the microwave paramagnetic resonance at $\nu \approx 9$ Gc for Nd: YES, Nd: LaES, Nd: LaMN, Sm: LaMN, Sm: LaES, Sm: YES, Er: LaES, and Er: YES, all for isotopes of spin I = 0 are examined. There is a decided anisotropy of the direct process, as large as 15: 1, which seems to be moderately well explained by the same simple theoretical procedure used for the temperature dependence. The Raman process was found to be independent of θ and H, as expected theoretically; likewise for the Orbach process, except for Nd: LaMN, where a small anisotropy is observed and explained. The data for the phonon-bottlenecked cases Ce: LaMN and Pr: LaMN indicate that the spins interact only with the phonons within the paramagnetic-resonance linewidth. The direct process for the various hyperfine lines of ^{167}Er in Er: YES and ^{143}Nd in Nd: LaMN is measured and found to exhibit a dependence on M_I and H in accordance with the theory of Baker and Ford, showing the importance of "forbidden" relaxation transitions $\Delta M_S = 1$, $\Delta M_I = \pm 1$. In a study of relaxation in (Er, Ce): LaES it is found that the Er relaxation rate is quite well explained in its dependence on both temperature and Ce concentration by resonance cross relaxation with Ce ions in the excited state at Δ = 5.7°K. (auth)

28645 OPTICAL ABSORPTION AND FLUORESCENCE INTENSITIES IN SEVERAL RARE-EARTH-DOPED Y_2O_3 AND LaF_3 SINGLE CRYSTALS. Krupke, William F. (Aerospace Corp., El Segundo, Calif.). Phys. Rev., 145: 325-37(May 6, 1966).

The absolute intensities of transitions occurring in the optical spectra of single crystals of Y_2O_3 doped with small amounts of Pr, Nd, Eu, Er, and Tm; single crystals of LaF_3 doped with small amounts of Pr and Nd; and single crystals of Er_2O_3, Tm_2O_3 and Yb_2O_3 were measured at room temperature. All observed transitions occur within the ground configurations of the trivalent rare-earth ions, and their intensities are accounted for using three phenomenological parameters for each system, whose values are determined by a least-squares fitting calculation. A calculation of the relevant crystal-field terms is made, and theoretical values for the intensity parameters are calculated using free-ion radial wave functions and certain closure approximations. It is concluded that excited $4f^{n-1}$ g configurations contribute to observed intensities more than is indicated by free-ion calculations, and that the excited $4f^{n-1}5d$ configuration contributes to the observed intensities an order of magnitude less than indicated by free-ion calculations. A hypersensitive transition in the neodymium systems is observed and its sensitivity is traced to a simple change in point symmetry of the host. (auth)

28646 POSITRON ANNIHILATION AND ORTHOG-ONALIZED PLANE WAVES IN LITHIUM. Meingailis,

J.; DeBenedetti, S. (Carnegie Inst. of Tech., Pittsburgh). Phys. Rev., 145: 400-5(May 13, 1966).

Anisotropies in the momentum distribution of positron annihilation radiation have in the past been observed in several single-crystal metals, most recently in Li. Interpretation of the results in terms of Fermi-surface structure is complicated. The angular correlation pattern is affected not only by the Fermi-surface shape but also by the Fermi-surface shape but also by the necessary departure of the conduction-electron wave function from a plane wave. The magnitude of these two effects is evaluated in Li. The orthogonalized-plane-wave method with 19 waves is used to obtain the lowest band, E(k), and the corresponding conduction-electron wave functions. The numerically calculated angular correlation curves show anisotropies in agreement with the measured results if both the effect of the Fermi-surface shape and the effect of the wave function are included. If the Fermi-surface shape alone is considered, the observed anisotropies cannot be explained. Quantitative agreement with experiment can be obtained if, in addition to all other effects, the enhancement factor due to electron-positron attraction calculated by Kahana is included. (auth)

28647 MOESSBAUER STUDY OF $^{57}Co(^{57}Fe)$ IN COBALTOUS OXIDE AT HIGH PRESSURE. Coston, C. J.; Ingalls, R.; Drickamer, H. G. (Univ. of Illinois, Urbana). Contracts AT(11-1)-1198; 1834(05). Phys. Rev., 145: 409-11(May 13, 1966). (COO–1198-313).

A room-temperature study of the Moessbauer effect of divalent ^{57}Co (^{57}Fe) in cobaltous oxide up to pressures of about 250 kbar is reported. As pressure is applied, the velocity spectrum unfolds from a single line into a hyperfine pattern in a manner consistent with the measured increase of the Néel temperature with pressure as reported previously. The pressure dependences of the internal magnetic field, electric field gradient, and isomer shift are described. (auth)

28648 PROFILES OF THE COMPTON BAND FROM LITHIUM. Theodossiou, Alexander; Vosnidis, Petros (Univ. of Athens). Phys. Rev., 145: 458-65(May 13, 1966).

Measurements are reported on the Compton profile from Li for the Cr Kβ radiation for scattering angles 10, 18, 32, and 45°. As the momentum transferred to the recoil electron depends on the scattering angle φ, a critical value φ_0 is found beyond which all the valence electrons contribute to the scattering. For the case $\varphi > \varphi_0$ the profile is known to be parabolic, while for $\varphi < \varphi_0$ the elementary theory predicts that the profile consists of a parabolic part which is continued by an inclined straight line terminating at the position of the unmodified line. The effort was mainly concentrated on scattering angles below φ_0. Because of experimental errors and also the nonmonochromatic nature of the primary radiation, it is difficult to determine the exact shape of the profile. But there is a discrepancy with the profiles calculated both by the Hartree-Fock approximation (noninteracting free-electron gas) and in the random-phase approximation (with Coulomb interaction). For scattering angle 45°, i.e., larger than φ_0, the measured half-width is 28 ± 5 ev, of the same order of magnitude as the value obtained by theory. (auth)

28649 EFFECT OF HIGH ELECTRONIC CURRENT DENSITY ON THE MOTION OF ^{195}Au AND ^{125}Sb IN GOLD. Gilder, H. Michael; Lazarus, David (Univ. of Illinois, Urbana). Phys. Rev., 145: 507-18(May 13, 1966). (COO–1198-297).

The effect of high electronic current density on the motion of the ^{195}Au and ^{125}Sb ions in gold was studied by means of a novel lathe-sectioning technique that permitted the assay of radioactive sections from a specimen only 3 mm in diameter. The mobility v/j of the ^{195}Au ion in gold was investigated in the temperature range 874 to 1016°C, with a corresponding variation in mobility of from 9.6×10^{-13} to 7.3×10^{-12} cm^3/A sec, and was found, within experimental uncertainty, to obey the Nernst-Einstein relation, $v/j = e^*\rho D/kT$. The effective charge e* was determined to be independent of temperature, with the value (9 ± 1)e, indicating that momentum exchange with the conduction electrons dominates the force arising from the direct interaction between the external electric field and the positively charged ion. The specific resistivity of the gold ion-vacancy complex was calculated to be (1.2 ± 0.3) $\mu\Omega$cm/(% defect). The electromigration of the ^{125}Sb ion in gold was studied at a temperature of 853°C, for which the mobility was 9.24×10^{-11} cm^3/A sec, and at 1009°C, corresponding to a mobility of 4.54×10^{-10} cm^3/A sec. The effective charge and specific resistivity of the activated complex are (140 ± 40)e and (18 ± 6) $\mu\Omega$ cm/(% defect), respectively. As the shift of the ^{125}Sb tracer was some 50% greater than the mean-square diffusional penetration distance of the antimony, and the mobility of the antimony ion some one to two orders of magnitude greater than that of the solvent gold atoms, it appears that electromigration techniques could be adapted as a practical method for purifying metals, as an addition to, or substitute for, zone refinement. (auth)

28650 NONLINEAR DE HAAS-VAN ALPHEN EFFECT AND MAGNETIC DOMAINS IN BERYLLIUM. Condon, J. H. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 145: 526-35(May 13, 1966).

The results of experiments that show that the wave shape of the magnetization oscillations (de Haas-van Alphen effect) depends on sample shape, and some results of magnetothermal oscillation experiments are presented. A theory that is an extension of Shoenberg's idea that the effective field on the conduction electrons is the induction B is developed. It is concluded that magnetic domains, similar in several respects to ferromagnetic domains, occur when the oscillating differential magnetic susceptibility $\partial 4\pi I/\partial B$ is greater than unity. (auth)

28651 ONE-PARTICLE PROPERTIES OF AN INHOMOGENEOUS INTERACTING ELECTRON GAS. Sham, L. J.; Kohn, W. (Univ. of California, San Diego, La Jolla). Phys. Rev., 145: 561-7(May 13, 1966).

In previous publications (especially by Hohenberg, Kohn, and Sham), a theory of the ground state of an inhomogeneous interacting electron gas was developed, in which the electronic density n(r) played a dominant role. This approach is extended to the one-particle Green's function and physical properties related to it, such as single-particle-like excitations and, in the case of metals, the Fermi surface. The Dyson mass operator Σ is studied as a function of its spatial arguments and as a functional of n(r), and, in both senses, it is found to have important short-range properties. An approximation for Σ, which is exact for systems of slowly varying density, is proposed. This leads to simple, explicit, Schroedinger-like equations for the single-particle-like excitations, whose solution determines their energies and lifetimes. In particular, it is shown how to apply this procedure to metals. (auth)

28652 THEORY OF QUANTUM CRYSTALS. Nosanow, L. H. (Univ. of Minnesota, Minneapolis). Phys. Rev., 146: 120-33(June 3, 1966).

The ground-state properties of quantum crystals (crystals of the isotopes of He and H_2) are studied by means of a variational calculation using cluster-expansion techniques. The cluster expansion for such a crystal is derived in a very general form and applied to a trial wave function that is assumed to be a product of one- and two-particle functions. The energy minimum is calculated by first truncating the expansion to retain only the one-particle and part of the two-particle term. In this form the calculation can be viewed as a Hartree calculation in which the true interaction is replaced by an appropriate effective interaction. The validity of the truncation is assessed by computing all of the leading correction terms. Calculations of the ground-state energy, pressure, and compressibility for the bcc and hcp structures of both ^3He and ^4He are presented as a function of molar volume. Although the calculated energies are too high, they represent a considerable improvement over previous work and the calculated pressures and compressibilities agree with experiment to about 10%. Tables of the

variational parameters which give the minimum energy are presented. A discussion of the accuracy of the approximations used to treat the correlations in the system is given. (auth)

28653 ELECTRON SPIN RESONANCE OF Nd^{3+} PAIRS IN $LaCl_3$ AND $LaBr_3$. Brower, K. L.; Stapleton, H. J.; Brower, E. O. (Univ. of Illinois, Urbana). Phys. Rev., 146: 233-43(June 3, 1966).

The electron-spin-resonance spectra due to Nd^{3+} pairs in $LaCl_3$ and $LaBr_3$ were examined. These measurements were made to 4.2°K and 9 kMc/sec using 0.1 at. % doping of enriched even-even isotopes of neodymium. A general anisotropic exchange interaction between two real spins is transformed into an effective-spin hamiltonian formalism containing a Zeeman term and a traceless coupling tensor A_{ij} between two effective spins each of magnitude $\frac{1}{2}$. This latter term represents an anisotropic effective spin interaction within the triplet levels of the system. About 5000 resonances due to allowed and forbidden transitions within these triplet levels were observed and fitted to this hamiltonian for various angles θ, between the magnetic field H and the crystal axis, and ϕ, between H and the plane containing a second-neighbor pair. Some resonances due to first-neighbor pairs were shifted by 2500 Oe from the unpaired-ion resonance and require analysis techniques other than perturbation theory. The observed symmetry of the second-neighbor interaction tensors in these two salts suggests that the halide ions play an important role. By removing the dipolar contributions to A_{ij}, quantitative results regarding the nature of the nondipolar spin-spin interaction are obtained. No resonances attributable to pairs were detected in $LaCl_3$ doped with either Ce^{3+} or Er^{3+}. (auth)

28654 DETERMINATION OF THE SPECTRAL DENSITY FUNCTION $J_1(\omega)$ IN SOLID ^{3}He FROM NUCLEAR-RELAXATION MEASUREMENTS. Richardson, Robert C. (Duke Univ., Durham, N. C.); Landesman, Andre; Hunt, Earle; Meyer, Horst. Phys. Rev., 146: 244-53(June 3, 1966).

The transverse and longitudinal relaxation times are studied theoretically in a system of nuclear spins where the modulation of the dipolar hamiltonian by an exchange interaction is the dominant relaxation mechanism. If the sample is a powder, it is shown that the nuclear-magnetic-resonance properties are entirely governed by the knowledge of one single spectral density function $J_1(\omega)$, which is determined experimentally for solid ^{3}He, for both bcc and hcp phases. The shape of $J_1(\omega)$ depends strongly on the lattice structure and, in the case of a bcc lattice, does not have the Gaussian shape proposed in the existing literature. Attempts were made to measure the second order frequency shift associated with the nonadiabatic broadening (10/3 effect); however, the experimental error was too large for the predicted shift to be measured. (auth)

28655 NONRELATIVISTIC THEOREM ANALOGOUS TO THE GOLDSTONE THEOREM. Lange, Robert V. (Brandeis Univ., Waltham, Mass.). Phys. Rev., 146: 301-3(June 3, 1966).

The Goldstone theorem states that a relativistic theory with a broken symmetry must have a zero-mass particle. In this context, broken symmetry means that the vacuum state is not invariant under the continuous group of transformations generated by the total charge operator referring to some microscopically conserved current. It is proved that if the ground state in a nonrelativistic theory lacks such invariance, there will exist an excitation with zero energy in the long-wavelength limit, so long as the interactions in the theory have finite range. For purposes of demonstration the Heisenberg model of ferromagnetism is employed, but the theorem holds for other nonrelativistic broken-symmetry theories as well. Special care is given the limiting procedures involved in the proof so that ambiguities found in previous work on this question are avoided. (auth)

28656 PLASMON EXCITATION BY CHARGED PARTICLES OUTSIDE A METAL FILM. Takimoto, Noboru (Univ. of New South Wales, Kensington, Australia). Phys. Rev., 146: 366-74(June 3, 1966).

A detailed study is given of the interaction between a metal film and a charged particle outside the film. It is shown in particular that a point charge Ze moving with a given initial velocity u in a direction parallel to the film excites surface plasmons in the film as a result of which a reaction force acts on the moving charge. Provided u is much larger than the Fermi velocity of the metal, and assuming specular reflection for scattering of the metal electrons at film boundaries, the force is given approximately by $[(Ze)^2/(2z_0)^2](\frac{1}{8}\pi)^{\frac{1}{2}}\alpha^{\frac{1}{2}}e^{-\alpha}$; $\alpha = \sqrt{2}\omega_p z_0/u$, for $\omega_p d/u \gg 1$ and $\alpha \gg 1$, and $[(Ze^2)/(2z_0)^2](\frac{1}{2}\pi)^{\frac{1}{2}}\beta^{\frac{1}{2}}e^{-\beta}$; $\beta = d\omega_p^2 z_0/u$, for $\omega_p d/u \ll 1$ and $\beta \gg 1$, where z_0 is the distance between the moving charge and the film, ω_p the volume plasmon frequency, and d the thickness of the film. A brief discussion is also given of the case of diffuse reflection. (auth)

28657 MAGNETIC HYPERFINE INTERACTIONS AND ELECTRIC QUADRUPOLAR COUPLING IN ALLOYS OF IRON WITH THE ALPHA-MANGANESE STRUCTURE. Kimball, C. W. (Argonne National Lab., Ill. Northern Illinois Univ., DeKalb); Phillips, Walter C.; Nevitt, M. V.; Preston, R. S. Phys. Rev., 146: 375-8(June 10, 1966).

The Mössbauer technique was used to investigate the magnetic hyperfine field and electric quadrupolar coupling at Fe nulcei in χ-phase ternary alloys and in antiferromagnetic MnFe alloys having the α-Mn structure. Alloys with 5, 10, 20, and 30 at.% Fe in α-Mn and the χ-phase alloys $\chi(V_{30}Si_{20}Fe_{50})$, $\chi(Ti_{17}Cr_{24}Fe_{59})$, and $\chi(Mo_{17}Cr_{21}Fe_{62})$ were examined at 4, 77, and 300°K. The data are consistent with the assumption that of the four available sets of sites, Fe occupies only sites III and IV. The Fe atoms appear to have no aligned 3d moment. For FeMn alloys the fact that the spectra at a given temperature are nearly independent of composition indicates that (1) the ratio between the Fe populations of the two sites is the same for each composition, and (2) the isomer shift, the magnetic field, and the electric-field gradient at an Fe site are not sensitive to whether neighboring atoms are Fe or Mn. A different Debye temperature is associated with Fe at each site. (auth)

28658 RELATIVISTIC ENERGY BANDS FOR THORIUM, ACTINIUM, AND LUTETIUM. Keeton, S. C.; Loucks, T. L. (Ames Lab., Ames, Iowa). Phys. Rev., 146: 429-31(June 10, 1966). (IS–1296).

The electronic energy bands were calculated for Lu, Th, and Ac using the relativistic augmented-plane-wave method. The importance of the relativistic effects in the rare earths is typified by the results for Lu, which show that the details of the Fermi surface will be altered considerably by these effects. As indicated by the bands for Th and Ac, the relativistic effects will be even more striking for the actinide series. (auth)

28659 ANNEALING OF RADIATION DAMAGE IN ZnSe. Detweiler, Robert M.; Kulp, B. A. (Aerospace Research Labs., Wright-Patterson Air Force Base, Ohio). Phys. Rev., 146: 513-16(June 10, 1966).

Electron bombardment of ZnSe at 80°K results in the production of two fluorescence bands at 5460 and 5850 Å. The threshold for damage at 80°K is 240 kev. When the sample is cooled to 4.2°K following bombardment at 80°K the fluorescence spectrum changes, reflecting the temperature dependence of the fluorescence; the peak at 5460 Å disappears, a new one at 6400 Å appears, and the peak at 5850 Å shifts slightly to a shorter wavelength. When the crystals are bombarded at 10°K, fluorescent peaks at 6100 Å and 6400 Å are produced. The threshold for radiation damage at 10°K is 195 kev. The radiation damage at high energies at 10°K anneals in three stages, one at about 60°K another at 90°K, and the final one at 135°K. The fluorescence spectrum changes following each of the first two annealing stages and disappears completely after the third annealing stage. With equal bombardment times, the fluorescence spectrum at 10 and at 80°K is identical, whether the crystal has been bombarded at 10°K and annealed at 90°K, or bombarded at 80°K without annealing. A Meechan and Brinkman plot was used to determine the activation energies and the order of reaction of the three annealing stages. (auth)

28660 ANALYSIS OF DEBYE-WALLER-FACTOR AND MOESSBAUER-THERMAL-SHIFT MEASUREMENTS. I. GENERAL THEORY. Housley, R. M.; Hess, F. (Univ., Groningen, Netherlands). Phys. Rev., 146: 517-26 (June 10, 1966).

A simple theoretical analysis is given of the dynamics of an arbitrary atom in a general harmonic solid. The atom under discussion may be an impurity. Several general results are found which limit the possible temperature dependences of the mean-square displacement and mean-square velocity in a way which is described. These results are expected to be most useful in analyzing experiments involving Debye-Waller-factor and Mössbauer-thermal-shift measurements. As an illustration the allowed range of mean-square displacements at T = 0 and T = 80°K corresponding to a measured value at T = 298°K is given. These results also provide strong consistency relations that experimental data or numerical calculations should satisfy. One especially interesting result indicates a possible method for determining a simple sum over atomic force constants from Debye-Waller-factor measurements. This sum, which in general is not obtainable from any other type of measurements, could be used as a convenient check on atomic-force-constant models. The dependence of the mean-square displacement and mean-square velocity on the various masses and force constants in the lattice is described. The relation between our results derived in the harmonic approximation and experimentally measurable quantities is discussed. Finally, several experiments which appear to be interesting are mentioned. (auth)

28661 EFFECT OF SIMULTANEOUS OPTICAL BLEACHING AND GAMMA RADIATION ON THE ROOM-TEMPERATURE COLORABILITY OF KCl. Mathews, J. W. (Emory Univ., Atlanta); Mallard, W. C.; Sibley, W. A. Phys. Rev., 146: 611-14(June 10, 1966).

The effect of simultaneous gamma irradiation and optical bleaching on F-center production in high-purity KCl at room temperature was investigated. It is found that for high gamma-ray intensities ($\sim 4 \times 10^3$ R/min) simultaneous irradiation and bleaching decreases the net F-center production rate compared with that characteristic of the same samples irradiated in the dark. This suppression of F centers is associated with the later stage of coloration and is a function of bleaching intensity and dose rate. When a sample is given the same total dose and amount of bleaching sequentially, there is a small net decrease in the F-center concentration. However, this decrease is much less than the amount of suppression observed in crystals irradiated in light. The effect of simultaneous bleaching and irradiation on the late-stage coloration suggests that the charge state of the radiation-produced vacancies, e.g., whether F centers or α centers are formed, is very important in the coloration process. In the case of low dose rates (~92 R/min) the F-center growth curves in dark-irradiated crystals consist of essentially only early-stage centers, whereas in samples simultaneously bleached and irradiated (light-irradiated), F-center production was completely suppressed. (auth)

28662 TEMPERATURE DEPENDENCE OF THE DEBYE-WALLER FACTOR FOR 14.4-kev γ RAYS OF ^{57}Fe IMPURITY NUCLEI IN Zn, Mo, AND Sn CRYSTAL LATTICES. Bara, J.; Cholewa, H. U.; Hrynkiewicz, A. Z.; Matlak, T. (Jagiellonian Univ., Krakow. Inst. of Nuclear Physics, Krakow). Phys. Status Solidi, 14: K147-50(Apr. 1, 1966).

Measurements of the temperature dependence of the Debye-Waller factor for 14.4-kev gamma rays of the iron-57 nucleus in zinc, molybdenum, and tin lattices are reported. Cobalt-57 diffusion in the metallic foils was also investigated, and optimum diffusion conditions were determined. (J.F.P.)

28663 MAGNETIC PROPERTIES OF GADOLINIUM–ALUMINIUM INTERMETALLIC COMPOUNDS. Stalinski, B.; Pokrzywnicki, S. (Technical Univ., Wroclaw). Phys. Status Solidi, 14: K157-60(Apr. 1, 1966).

The magnetic characteristics of the intermetallic compounds of gadolinium-aluminum alloy are investigated. All four known compounds of this system Gd_3Al_2, GdAl, $GdAl_2$, and $GdAl_3$ were studied, and their symmetry structure, and lattice constants are given. Curves for the temperature dependence of the reciprocal magnetic susceptibility, and the magnetization at 9280 Oe are shown. Also the effective moment, Weiss constant, Curie point, and saturation moment are given. (J.F.P.)

28664 RADIATION ANNEALING IN CUPROUS OXIDE. Vajda, P. (Danish Atomic Energy Commission, Risoe). Phys. Status Solidi, 14: 287-90(Apr. 1, 1966).

Experimental results from high-intensity γ-irradiation of cuprous oxide are used to investigate the annealing of defects with increasing radiation dose. The results are analyzed on the basis of the Balarin and Hauser statistical model of radiation annealing, giving a square-root relation between the rate of change of resistivity and the resistivity change. The saturation defect density at room temperature is estimated on the basis of a model for defect creation in cuprous oxide. (auth)

28665 NMR EVIDENCE FOR CONTACT HYPERFINE COUPLING IN PARAMAGNETIC UF_4. Pintar, M. (Nuclear Inst. J. Stefan, Ljubljana, Yugoslavia). Phys. Status Solidi, 14: 291-5(Apr. 1, 1966).

The ^{19}F NMR absorption in powdered UF_4 is investigated in the temperature range 122 to 433°K at magnetic fields between 10,000 and 5,000 G. The fluorine absorption pattern in this paramagnetic material with seven nonequivalent F-sites in the unit cell is reproduced qualitatively by a sum of six asymmetric component lines $(H_{||} - H_{\perp})^{-\frac{1}{2}} \times (H - H_{\perp})^{-\frac{1}{2}}$, some of which are shifted in the high field direction, and some in the low field direction. The occurrence of low-field shifted components provides evidence of contact hyperfine interaction between the magnetic electrons and the fluorine nuclei whereas the occurrence of high-field shifted components may arise from indirect coupling through electron transfer, and indicates partial covalent bonding between the magnetic electrons and the surrounding fluorine ions. This is supported by magnetic susceptibility and EPR data. (auth)

28666 INVESTIGATIONS ON LATTICE CHARACTERISTICS IN THE LiH–LiD SYSTEM. Brueckner, W. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.), Kleinstueck, K.; Schulze, G. E. R. Phys. Status Solidi, 14: 297-302(Apr. 1, 1966). (In German).

The lattice constants and the thermal expansion coefficients of four compounds of the mixed crystal system LiH–LiD with 0, 50, 75, and 100 atomic percent deuterium are determined by neutron diffraction and dilatometric methods, respectively. The values obtained for the mixed crystals are found to be somewhat greater than predicted by the Vegard law. This suggests a correlation between atoms of the same kind in the H-D-sublattice. The observed differences in the investigated lattice properties of LiH and LiD are compared with the theory of Ubbelohde and London, and the discrepancies are briefly discussed. (auth)

28667 TEMPERATURE DEPENDENCE OF THE PHOTOEFFECT ON ANODICALLY PREPARED ZrO_2 LAYERS. Hartl, M.; Achtziger, K. (Technische Hochschule, Munich). Phys. Status Solidi, 14: 355-62(Apr. 1, 1966). (In German).

The zero-field photoelectric behavior of anodized Zr sheets with metal counter electrodes illuminated with uv light is measured as a function of temperature in the range +25 to −150°C, for oxide film thicknesses between 75 and 1500 Å. The short circuit photocurrent decreases rapidly with decreasing temperature, and this decrease is found to become more rapid as the thickness increases and eventually becomes almost exponential. To explain this behavior, it is assumed that the diffusion length of the photo-carriers, separated by a potential gradient in the oxide, has a similar temperature dependence to the photocurrent. The photovoltage in thin layers (≤500 Å) is almost temperature-independent and in thicker layers is found to decrease with temperature. These results do not agree with previous high photovoltage values at low temperatures.

It is also shown that different behavior arises when evaporated Zr is used. (auth)

28668 OPTICAL ABSORPTION OF LiF CRYSTALS IRRADIATED WITH NEUTRONS AT LIQUID NITROGEN TEMPERATURE. Kamikawa, T.; Kazumata, Y.; Ozawa, K. (Japan Atomic Energy Research Inst., Tokyo). Phys. Status Solidi, 14: 435-44(Apr. 1, 1966).

The effects of low temperature neutron irradiation on LiF single crystals are investigated by optical absorption measurements. The crystals are irradiated and measurements made at 80°K. In the spectra obtained at 77°K, the V_K- and M-bands appear prominently but the F-band is hidden under other overlapping bands. A noticeable band found at 578 nm is suggested to be associated with the Li interstitials. During thermal annealing, three absorption peaks are observed at 415, 430, and 443 nm in the M-band region. The new band at 415 nm shows a fine structure at 77°K. A new absorption band at 545 nm, called the S-band, is observed to increase in thermally bleached crystals after aging at room temperature. The experiments on doped crystals show that the divalent cations modify the characteristics of low temperature neutron irradiation. In the doped crystals, the 578 nm band due to the Li interstitials is not observed. When a very large band at about 400 nm is partially bleached, many sharp lines are observed. Their origin is discussed briefly. (auth)

28669 CRYSTAL PHYSICS OF RARE EARTH COMPOUNDS. Hellwege, K. H. (Institut fuer Technische Physik, Darmstadt, Ger.). pp 328-67 of Physikertagung 1965 Frankfurt (M)-Hoechst, Okt. 4-9. Plenarvortraege. Stuttgart, B. G. Teubner Verlagsgesellschaft mbH, 1965. (In German).

For lead abstract see CONF-651030-(Vol.2) in report number index.

The fundamentals of the models describing rare earth compounds are reviewed. The static single atom model, free ions and crystal lattices, the dynamic single atom model, and the multi-atom model are discussed. (J.S.R.)

28670 DETECTION OF THE OSCILLATION STATE OF HYDROGEN IN COMPOUNDS AND IN SOLIDS BY THE INELASTIC SCATTERING OF COLD NEUTRONS. Kley, W. (EURATOM, CCR, Ispra, Italy). pp 66-72 of Physikertagung 1965 Frankfurt (M)-Hoechst, Okt. 4-9. Vorabdrucke von Kurzfassungen der Fachberichte. Stuttgart, B. G. Teubner Verlagsgesellschaft mbH, 1965. (In German).

For lead abstract see CONF-651030-(Vol.1) in report number index.

In addition to the known ultraviolet and Raman spectrometry, the inelastic scattering of thermal and subthermal neutrons has been used in recent years for the investigation of the self oscillation states in solids and liquids. The advantages and limitations of the neutron measurement methods were discussed. The self oscillation states of hydrogen as a foreign atom in metals and ferroelectric compounds are treated. (tr-auth)

28671 PARAMAGNETIC RELAXATION IN RARE EARTH COMPOUNDS. Weber, G. (Institut fuer Technische Physik, Darmstadt, Ger.). pp 93-6 of Physikertagung 1965 Frankfurt (M)-Hoechst, Okt. 4-9. Vorabdrucke von Kurzfassungen der Fachberichte. Stuttgart, B. G. Teubner Verlagsgesellschaft mbH, 1965. (In German).

For lead abstract see CONF-651030-(Vol.1) in report number index.

The spin-lattice and the cross relaxation mechanism in paramagnetic ionic crystals and the measurement methods for the determination of relaxation times were described. The measurements show that the Van Vleck-Orbach theory describes the spin-lattice relaxation process very well in rare earth salts. Measurements of cross relaxation in multiterm systems were reported and discussed with consideration with the electron spin, crystal field, and nuclear spin. (tr-auth)

28672 CRITICAL SCATTERING OF NEUTRONS FROM MAGNETIC MATERIALS. Marshall, W. (Atomic Energy Research Establishment, Harwell, Eng.). pp 155-61 of Physikertagung 1965 Frankfurt (M)-Hoechst, Okt. 4-9. Vorabdrucke von Kurzfassungen der Fachberichte. Stuttgart, B. G. Teubner Verlagsgesellschaft mbH, 1965.

For lead abstract see CONF-651030-(Vol.1) in report number index.

The theory of neutron scattering from a ferromagnet near the Curie temperature is reviewed. Studies of the detailed nature of the scattering show that well established theories of the phenomena are oversimplified. (J.S.R.)

28673 THEORY OF THE ELECTRON ORBITAL CONTRIBUTION TO THE SCATTERING OF NEUTRONS BY MAGNETIC IONS IN CRYSTALS. Johnston, D. F. (Atomic Energy Research Establishment, Harwell, Eng.). Proc. Phys. Soc. 88: 37-52(May 1966).

A new treatment of the theory of the scattering of slow neutrons by magnetic ions in crystals is given in which the use of different sets of radial integrals for the electron orbital and spin contributions is avoided. This simplification makes it possible to analyze experimental form factor data in terms of a smaller number of radial integrals, commonly two in place of four. (auth)

28674 COVALENCY IN OCTAHEDRALLY CO-ORDINATED Yb^{3+}. Thornley, J. H. M. (Clarendon Lab., Oxford). Proc. Phys. Soc. (London), 88: 325-32(June 1966).

A theory for covalent octahedrally co-ordinated Yb^{3+} is developed. A system of molecular orbitals is set up, and the orbital contribution to the g value and the hyperfine interactions with the ligand nuclei are evaluated for the lowest doublet. The model neglects electron transfer into central ion 5d, 6s, and 6p orbitals. (auth)

28675 ISOTOPE SHIFTS FOR ZERO-PHONON AND PHONON-ASSISTED TRANSITIONS IN LITHIUM FLUORIDE. Hughes, A. E. (Atomic Energy Research Establishment, Harwell, Eng.). Proc. Phys. Soc. (London), 88: 449-62(June 1966).

Zero-phonon absorption lines at 3909, 4874, and 5234 Å associated with radiation induced color centers were examined at 4°K in single crystals of ^{6}LiF and ^{7}LiF. Red shifts of all the lines were observed in ^{6}LiF relative to their positions in ^{7}LiF, the largest shift being 6.8 ± 0.4 cm^{-1} for the 4874 Å line. Large shifts were also observed in some of the phonon-assisted transitions accompanying the 5234 Å line. No changes in the isotope effects were observed at 77°K, although all lines shift to the red and broaden. It is shown that the isotope shift for the zero-phonon lines may be regarded as the sum of two parts: a "static shift" caused by the fractional increase in lattice constant for ^{6}LiF and a "dynamic shift" resulting from quadratic coupling between the electronic states of the defect and the lattice normal modes. This coupling is also responsible for part of the temperature shifts. The contribution of the static shift may be found from measurements under applied stress, while a formula is derived which expresses the dynamic shift in terms of moments of the one-phonon spectrum. Shifts of the correct order of magnitude and direction were calculated on this basis. Finally, in the light of their isotope shifts, the frequencies of phonon-assisted peaks for the 5234 Å line are compared with dispersion curves calculated by Karo and Hardy in 1963. (auth)

28676 SECOND-ORDER QUADRUPOLE EFFECT FOR THE NUCLEAR QUADRUPOLE ANTI-SHIELDING FACTOR. Ghatikar, M. N. (Saha Inst. of Nuclear Physics, Calcutta). Proc. Phys. Soc. (London), 88: 536-8(June 1966).

The numerical estimations for the induced quadrupole moment due to the second-order perturbation of the ion by the field of the nuclear quadrupole moment were made in the case of Pr^{3+} and Tm^{3+} ions and are found to be very small. (auth)

28677 CONDUCTIVITY INDUCED BY ELECTRON BOMBARDMENT IN ANTHRACENE. Delany, J. L.; Hirsch, H. (London Univ.). Solid State Commun., 4: 107-9(Mar. 1966).

Using short pulses of nonpenetrating electrons, electron and hole mobilities of the order 1 cm^2 sec^{-1} v^{-1} are found

in anthracene single crystals. The field dependence of the collected charge, and the small gain (≈10) for the current induced by penetrating electrons, are explained by a simple model which yields recombination lifetimes of $\approx 10^{-8}$ sec and a quantum efficiency for carrier pair production of ≈5%. (auth)

28678 SPIN DIFFUSION. Khutsishvili, G. P. Usp. Fiz. Nauk, 87: 211-54(Oct. 1965). (In Russian).

A review is given of magnetic relaxation and dynamic polarization of nuclei in a diamagnetic crystal with a low concentration of paramagnetic atoms. Examples of four types of specimens are given: a dilute paramagnetic salt; an oxide or halide of a nontransition metal with a small concentration of a transition metal; an alkali halide crystal with F-centers; and a crystal containing free radicals. A brief outline is given of the theory of direct relaxation and dynamic polarization of nuclei due to dipole-dipole interaction with magnetic ions. The mechanism responsible for diffusion of nuclear spin is described and the theory of magnetic relaxation and dynamic polarization of nuclei with regard to spin diffusion is discussed. Experimental and theoretical data are compared. (ATD)

28679 AN INVESTIGATION OF THE CONFIGURATIONS OF INTERSTITIALS IN BCC METALS BY ELASTIC METHOD. I. THE POSITION ENERGY AND ACTIVATION ENERGY OF DIFFUSION OF INTERSTITIAL IMPURITIES. Yang, C. C. (Nanking Univ., China). Wu Li Hsueh Pao, 22: 281-93(Mar. 1966). (In Chinese).

Assuming the metals to be an isotopic, unbounded and homogenous elastic continuum, the tetrahedral and octahedral position energy of interstitials (C,N,O and H) in bcc metals (Fe, W, Mo, Ta, and Nb) are evaluated by means of the concept of elastic dipole. The results show that all of them occupy the octahedral positions except H, which in W, Mo, Ta, and Nb favors the tetrahedral position, and the critical radius of interstitials at which the favored position is exchanged are given also. The activation energies of interstitials moving between octahedral positions are calculated. The results are compared favorably with previous experiments. (auth)

28680 AN INVESTIGATION OF THE CONFIGURATIONS OF INTERSTITIALS IN BCC METALS BY ELASTIC METHOD. II. THE INTERACTIONS BETWEEN INTERSTITIALS AND THEIR ORDERING. Yang, C. C. (Naking Univ., China). Wu Li Hsueh Pao, 22: 294-303(Mar. 1966). (In Chinese).

By using the results obtained previously, the interaction energies between interstitials in various relative configurations are calculated, the results closely agree with the previous work both in theory and experiment. The stable configurations of interstitial impurity groups having atoms of various numbers are projected. The order-disorder transition of interstitials in bcc metals is investigated by means of a method similar to Cowley's theory of ordering of substitutional solid solutions, the Curie temperature of ordering of O in Ta and Nb is obtained and in agreement with the experimental results. (auth)

28681 X-RAY ISOCHROMATS OF SOME RARE EARTH ELEMENTS. Bergwall, Staffan (Uppsala Univ.). Z. Phys., 193: 13-22(1966).

Recordings of the isochromat curves of the rare earth elements 64 Gd to 71 Lu were made by means of a high vacuum spectrometer provided with a bent topaz crystal. The information concerning the density of states N(E) near the Fermi limit is compared with that deduced from specific heat measurements. The results obtained from the isochromat curves are rather constant, which on account of the atomic configuration in these elements is expected. An observed anomaly in the band structure of Tb metal is discussed. The appearance of this anomaly indicates that a rigid band model is not applicable to some of the actual elements. (auth)

28682 ANISOTROPY OF THE REFLECTION OF ARGON IONS FROM A COPPER SINGLE CRYSTAL. Yurasova, V. E.; Brzhezinskii, V. A.; Ivanov, G. M. Zh. Eksp. Teor. Fiz., 47: 473-5(1964). (In Russian).

Results of investigation of the reflection of ~1.5 kev Ar ions from the (100) surface of a Cu single crystal are presented. Regularity of the crystal lattice is found to affect the intensity of the reflected ions. Minimal reflection is observed in the close-packed directions [110] and [100]. Ion reflection is maximal at directions lying between these two. (auth)

28683 EXPERIMENTAL AND THEORETICAL STUDIES OF NUCLEAR MAGNETIC RESONANCE IN ROTATING SOLIDS. Schnabel, B. Jena, Ger., Univ., 1964. 62p. $2,00 Gmelin, AED-Diss. 64-1069.

The design and construction of a resonance spectrometer including a turbine for measurements with rotating samples are described. Residual line broadnesses are explained by spin-lattice relaxations. Results indicate that rigid lattices are necessary in order to produce high resolution spectra. (Gmelin Inst.)

28684 REACTIVITY OF SOLIDS. 5th International Symposium on the Reactivity of Solids, Munich, August 2nd–8th, 1964. Schwab, G.-M. (ed.). New York, Elsevier Publishing Co., 1965. 702p. (CONF-489).

Sixty-one articles on: phase transformations; luminescence; organic crystals; kinetics; defects; oxides and oxidation; formation of phases; decompositions; ferrites; and syntheses are included. Summaries of 5 Plenary lectures are also given. (P.C.H.)

REACTOR TECHNOLOGY

General

Refer also to abstract 27207.

28685 (BMI-X-10163) AN EVALUATION OF THE APPLICABILITY OF EXISTING DATA TO THE ANALYTICAL DESCRIPTION OF A NUCLEAR-REACTOR ACCIDENT. Quarterly Progress Report, January–March 1966. Morrison, David L.; Gieseke, James A.; Ritzman, Robert L.; Walters, Craig T.; Genco, Joseph M.; Sunderman, Duane N. (Battelle Memorial Inst., Columbus, Ohio). Apr. 1, 1966. Contract W-7405-eng-92. 45p. (EURAEC-1641). Dep. mn. CFSTI $2.00 cy, $0.50 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Specific studies were made in the areas of heat transfer and thermodynamics, fission-product chemistry, and aerosol and particle dynamics during a reactor loss-of-coolant test. Hydrogen combustion associated with metal-water reactions was investigated. Calculational methods for fission product dynamics during meltdown are described. (M.O.W.)

28686 (ORNL-3943) ESTIMATION OF FUEL-SHIPPING COSTS FOR NUCLEAR POWER COST-EVALUATION PURPOSES. Salmon, Royes (Oak Ridge National Lab., Tenn.). Mar. 1966. Contract W-7405-eng-26. 67p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

An attempt was made to provide a detailed basis for shipping-cost estimation, so that differences inherent in the reactor and fuel assembly design may be accounted for. The methods presented follow generally the the approach used by the author in computer codes MYRA and NORA. The major new features are that (1) design charts based on data correlations are used as a means of arriving at an approximate cask design, whereas the previous work depended on the use of computer codes, (2) the scope of the work was enlarged to cover the shipment of fresh fuels, including those containing gamma-active recycled materials, and (3) a section on the shipment of certain fuel chemicals was added. Recent changes in shipping regulations (December 1965) governing cask design were also taken into account. (auth)

28687 (ORNL-TM-1386) IODINE TRANSPORT AND DEPOSITION IN A HIGH-TEMPERATURE HELIUM LOOP. Second Series of Tests. Neill, F. H.; Gray, D. L.; Kress, T. S. (Oak Ridge National Lab., Tenn.). June 1966. Contract W-7405-eng-26. 44p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

The mass transport of trace amounts of iodine in a turbulently flowing helium stream and its deposition onto various surface materials were investigated. Tests were carried out with deposition surfaces of copper, silver, mild steel, and stainless steel in the temperature range of 400 to 500°F. The results indicate that iodine tends to saturate surfaces at different levels of iodine concentration, and that it tends to desorb spontaneously at rates that differ for the various surface materials. Flow perturbations affected by a sudden enlargement of the flow duct resulted in an increase in the peak mass-transfer coefficients similar to reported changes in heat-transfer coefficients for similar changes in geometry. In addition, studies of deposition on small-diameter wires arranged in arrays perpendicular to the coolant stream indicate that deposition predicted by the heat-mass transfer analogy will give reasonable correlations with experimental results. (auth)

28688 STATISTICAL METHODS FOR MEASUREMENT OF THE ABSOLUTE POWER OF REACTORS. Mogil'ner, A. I.; Shvetsov, D. M. At. Energ. (USSR), 20: 117-23(Feb. 1966). (In Russian).

The use of different statistical methods for the measurement of the absolute power of reactors is described. It is shown that current methods are preferable to pulse methods. (tr-auth)

28689 THE FORMATION OF SHOCK WAVES FROM THE COMBUSTION OF GASEOUS MIXTURES WITH SPECIAL CONSIDERATION OF THE SODIUM–AIR REACTION. Moore, J. G. (United Kingdom Atomic Energy Authority, Risley, Eng.). Nucl. Eng. Design, 3: 320-37(1966).

The formation of shock waves due to combustion processes was considered. Three theoretical models were proposed which are appropriate to different assumed modes of combustion. The shock strengths calculated using these models were found to be significantly different. The attenuation of the shock waves due to three-dimensional spreading is considered and also the interaction of shock waves with rigid boundaries. The sodium-air reaction is used as the basis for numerical results with the view to hazard evaluation for sodium-cooled reactors. (auth)

28690 NUCLEAR REACTOR REACTIVITY CONTROL. Maldague, Pierre E. J. M. (to Societe Anglo-Belge Vulcain Societe Anonyme). Canadian Patent 730,258. Mar. 15, 1966. Priority date Feb. 28, 1961, Belgium.

By employing a liquid moderator and liquid coolant distinct from one another either by their nature or because they flow in separate circuits, reactivity is adequately controlled. The composition and temperature of both can be varied as a further reactivity control measure for use when the burnup proceeds to higher values. For example, means are provided for varying the light water/heavy water ratio in the moderator while the reactor is operating under power. (F.S.A.)

Auxiliaries and Components

Refer also to abstracts 26927, 27119, and 27123.

28691 (APDA-185) QUARTERLY TECHNICAL PROGRESS REPORT ON AEC-SPONSORED ACTIVITIES, JANUARY–MARCH 15, 1966. (Atomic Power Development Associates, Inc., Detroit, Mich.). Contract AT(11-1)-865. 68p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Technical progress is summarized on Paste concept for fast reactor blanket application, Na–water reactions, Na loop investigations, fuel element flow stability studies, scanner for under-Na object location, compilation of Fermi experience, fast flux test facility design, and holding device for small tensile specimens. (J.R.D.)

28692 (BNWL-SA-655) PROCESS COMPUTER APPLICATIONS AT BATTELLE-NORTHWEST. Driver, G. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 21, 1966. Contract AT(45-1)-1830. 9p. (CONF-660527-1). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From Symposium on Use of Computers in Analysis of Experimental Data and Control of Nuclear Facilities, Argonne, Ill.

Included is a description of Battelle-Northwest's application of digital computer technology to on-line data acquisition from experiments and in automatic control of nuclear processes. (auth)

28693 (CEA-R-2940) VARIATION DES CONSTANTES DE TEMPS DE FILTRAGE DANS LES PERIODEMETRES LOGARITHMIQUES, RESULTATS ET POSSIBILITES (1964). (Variation of Time Constants in the Filters of Logarithmic Period Meters —Results and Possibilities (1964)). Faraguet, Claude; Quenee, Robert (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jan. 1966. 36p. Dep. mn.

The optimum transfer function for a d-c logarithmic periodmeter shows that it is necessary to choose the

time constant of the filters in accordance with the number of informations given by the neutron detector, if it is desirable to obtain short response time. Theoretical and experimental results of a d-c logarithmic periodmeter using a filter with time constants with level of the d-c output signal of the logarithmic amplifier are given when a d-c ionization chamber is used. Theoretical results are also given when a neutron pulse detector is used. A prototype of the periodmeter is also described. (auth)

28694 (GEAP–4964) REACTOR PRIMARY COOLANT SYSTEM RUPTURE STUDY. Quarterly Progress Report No. 2, July–September 1965. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Oct. 1965. Contract AT(04-3)-189. 131p. Dep. mn. CFSTI $4.00 cy, $1.00 mn.

During the current report period efforts were concentrated on developing a "list of sensitive factors" and on formulating the basic reliability model. The sensitive factor list has been completed and is included. Development of the complex reliability model has proceeded more slowly. An initial example was constructed to demonstrate the way in which reliability techniques can be applied to piping components and set-up work on a prototype BWR model has continued. Computer programming efforts have concentrated on development of the irregular flat and curved trapezoidal elements. Initial compilation of the stress concentration factors for use with the computer program was completed. Work in the fracture mechanics area during the last quarter has concentrated on completing the "state of the art" report and on setting up the facility for measuring fracture toughness of piping steels. Both analytical and experimental portions of the crack growth studies continued satisfactorily. In the analytical effort some available fatigue test results on pipes were compared with predicted behavior using several current fatigue crack growth laws. In the experimental work, two crack growth tests of Type 304 stainless steel were completed. Evaluation of the A-212B steel for conformity with specification was completed and the A-387D alloy steel is being tested. Crack initiation studies concentrated on obtaining smooth bar data and checking the reliability of strain sensing elements. Smooth bar data for low carbon steel and Type 304 stainless steel were established. The 2¼ Cr-1 Mo steel will be evaluated in the next quarter. Specimen and fixture preparation for the notched specimen series is continuing. The prototype test program was re-examined and the number of individual tests was reduced. Design of the prototype test facility was completed and manufacturer's bids were solicited. (auth)

28695 (GEAP–5082) REACTOR PRIMARY COOLANT SYSTEM RUPTURE STUDY. Quarterly Progress Report No. 3, October–December 1965. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Jan. 1966. Contract AT(04-3)-189. 60p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

During the current report period, initial development of the basic reliability equations was completed. Work on the BWR Primary Piping System Reliability model has continued and parametric evaluation of component and system reliabilities is being initiated. Computer code development efforts have concentrated on programming flat and curved trapezoidal and triangular plate elements. Both flat and curved trapezoidal elements were completely programmed. The flat triangular element equations were derived and the program coded for the GE 625. Checkout of this element is underway. Development of an analytical model of a 6 × 10 piping tee is underway using a network of beams which approximate the properties of the tee. A general procedure is being developed for locating the beam ends so the gridwork of the model is small near the shell intersections where the stresses change rapidly. Initial scoping of the experimental stress analysis program was completed. Third quarter efforts in the fracture mechanics area concentrated on developing a method for obtaining fracture toughness data for piping steels. A series of tests is being conducted to investigate the limitations on fracture toughness measurements with specimens small enough to be cut from the walls of typical pipes. Tests thus far were limited to impact tests with Charpy-type specimens and tensile tests with the so-called wedge-opening loading (Manjoine) specimen. Initial results indicate that reasonably good agreement can be obtained from Charpy specimens which were nitrided to suppress shear lip formation. Both the analytical and experimental work on crack growth has continued. Experimental efforts consisted of measurement of cyclic crack growth in A-212 Grade B steel at room temperature and at 480°F and in Type-304 stainless steel at room temperature. Crack growth rate for the carbon steel at elevated temperature was found to be significantly higher than at room temperature. In the analytical effort, some available data on the size of natural defects in welded piping were examined to obtain an estimate of the magnitude of defects in service piping and thus provide some guidance for plate and prototype tests. Strain gage evaluation work and determination of cycles to failure data for smooth bar specimens was completed. Machining of notched cylinder and plate specimens is complete and testing is being initiated. (M.O.W.)

28696 (GEAP–5084) RADIAL VANE STEAM SEPARATOR DEVELOPMENT. Quarterly Report No. 6, October–December 1965. Moen, R. H. (General Electric Co., San Jose, California, Atomic Power Equipment Dept.). Jan. 1966. Contract AT(04-3)-189. 102p. (EURAEC–1598). Dep. mn. CFSTI $4.00 cy, $0.75 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

The major share of the FCRV-3 and FCRV-4 steam separators testing was completed during the quarter. These tests showed satisfactory carryover, carryunder, and pressure drop performance of the model radial vane separator in air-water service. Nozzle lengths up to the maximum available (30 in.) were tested, and tests were carried out with all vanes active (maximum nozzle length = 12 in.). The tests also show that the upper vortex thickness can be predicted satisfactorily, that turning vanes (plenum deflectors) are not required (but could be used to decrease the upper vortex thickness if desired), and that the upper vortex surface is relatively smooth and not unstable. Equipment was designed and built to study the distribution of carryunder in the wall flow. Equipment was designed to determine the effect of vertical steam velocity on separation on the vanes. (auth)

28697 OPERATION OF 30-Mev MICROTRON INJECTOR FOR PULSED FAST REACTOR. Anan'ev, V. D.; Antsupov, P. S.; Kapitsa, S. P.; Matora, I. M.; Melekhin, V. N.; Merkulov, L. A.; Khar'yuzov, R. V. At. Energ. (USSR), 20: 106-11(Feb. 1966). (In Russian).

A neutron source is described in which a 30-Mev electron beam with a current of 60 mamp/pulse is injected into the reactor core. (D.C.W.)

28698 INFLUENCE OF PURIFICATION ON THE ACTIVITY BUILDUP OF CORROSION PRODUCTS IN PWR SYSTEMS. Veselkin, A. P.; Shakh, O. V. At. Energ. (USSR), 20: 247-52(Mar. 1966). (In Russian).

The formation, accumulation, and transfer of corrosion products in pressurized-water reactors are considered as well as the effect of purification systems. The solutions of the associated differential equations are outlined, and an analysis of the solutions is given. It is shown that the efficiency of a purification system depends essentially on the activity of the water and the deposition of corrosion products. (D.C.W.)

28699 RIG FOR IN-PILE POWER CYCLING OF FUEL PINS. Biermann, W. (Deutsche Babcock and Wilcox Dampfkessel-Werke AG, Oberhausen, Ger.); Granner, N.; Husmann, K.; Kohler, H.; Spalthoff, W. Kerntechnik, 8: 164-5(Apr. 1966). (In German).

The design and preliminary operational experiments with the in-pile cycling device for use in the gas-cooled reactor are described. (J.S.R.)

28700 RELIABILITY ASSESSMENT OF PROTECTIVE SYSTEMS. Eames, A. R. (United Kingdom Atomic Energy Authority, Risley). Nucl. Eng., 11: 188-92(Mar. 1966). (AHSB(S)R-99).

A method for reliability assessment of reactor protective systems is outlined. The fault rates for many components are tabulated and some means of detection are discussed. (G.O.Y.)

28701 NEW REACTOR CONTAINMENT CONCEPT BY ENERGY ABSORPTION. Fistedis, Stanley H. (Argonne National Lab., Ill.). Nucl. Eng. Design, 3: 281-6(1966).

Primary containment of nuclear power plants, as affected by maximum accident considerations, was provided in the past through structural entities commonly designed to satisfy pressure-volume calculations. This approach, due to the large and fictitious pressures involved in the calculations, did not disclose the presence and magnitude of existing margins of safety. A more realistic approach equating the destructive component of energy in the maximum accident to the strain energy of the material confining the reactor was initiated. Material (high-tensile-strength steel strands) capable of exhibiting large amounts of elastic and plastic strain was considered and found suitable to absorb the destructive component of energy for most reactors heretofore constructed. Resulting configurations of energy-absorbing devices appear entirely feasible. In addition to very substantial reductions in the cost of primary nuclear containment, the concept offers a clear approach to a realistic assessment of safety margins available in maximum reactor accidents. A modified version of this containment concept is presently applied in an experimental facility design. Practically all structural materials employed are off-the-shelf items. Also a simple erection procedure was devised. (auth)

28702 PRESTRESSED CONCRETE REACTOR PRESSURE VESSEL MODEL TESTS. Baker, A. L. L. (Imperial Coll. of Science and Tech., London). Nucl. Eng. Design, 3: 363-4(1966).

Tests on a model of a prestressed concrete reactor pressure vessel are described. These tests were made to investigate the structural behavior of a design of this type and provide information that would permit the improvement of practical designs. A general view of the test hall, the model, and some of the supporting control tests is shown. (J.F.P.)

28703 IMPROVEMENTS IN OR RELATING TO SOLID MODERATOR STRUCTURES FOR NUCLEAR REACTORS. Prince, Kenneth (to United Kingdom Atomic Energy Authority). British Patent 1,025,617. Apr. 14, 1966. Filed Apr. 10, 1963.

A moderator structure for a reactor consists of graphite blocks at least in partial contact and having coolant channels extending through the structure. A series of discrete grooves are spaced along the length of the walls of the coolant channel. Each groove is substantially normal to the direction of the channel wall to help relieve axial stresses in the graphite. (B.L.M.)

28704 STACKS OF SOLID-MODERATOR RODS FOR NUCLEAR REACTORS. Lemesle, Georges; Manes, Roger; Rouge, Pierre (to Commissariat a l'Energie Atomique). Canadian Patent 723,260. Dec. 7, 1965. Priority date Nov. 20, 1961, France.

Hollow rods or columns of moderator material are fabricated with peripheral grooves and ribs or splines to tie adjoining vertical columns together. The design is such that the distance from the axis of the column to the bottom of a groove is the same as the distance from the axis to the base of a rib. Economy of material and greater strength are achieved by such an arrangement. The columns are, in general, either circular or hexagonal in shape. No continuous path is offered for neutron escape. (AECL)

28705 NUCLEAR FUEL CARTRIDGE ALIGNMENT STRUCTURE. Liermann, Jean (to Commissariat a l'Energie Atomique). Canadian Patent 723,261. Dec. 7, 1965. Priority date Apr. 6, 1962, France.

Slugs or cartridges are aligned in a reactor fuel channel by adding an annular ring with small projections which fit into one another. The alignment mechanism, however, does not bear the weight of the slug column. The projections and the weight bearing surfaces are threaded on to the ends of each cartridge. By this means the slugs may be loaded into the channel with perfect alignment. (AECL)

28706 NUCLEAR REACTOR WITH MOLDED BODIES GUIDED IN TUBES THROUGH THE CORE. Boetcher, Alfred (to Deutsche Gold- und Silber-Scheideanstalt). German Patent 1,207,023. Dec. 16, 1965. Filed Nov. 26, 1959.

Small fuel-element units (balls, cylinders, discs) are guided through the core by means of liquid-filled (conical) spiral tubes. The liquid medium filling the tubes must on the one hand facilitate the movement of the fuel elements in the tubes and on the other hand serve for the heat transfer from the fuel to the tube wall. The free ends of the spiral tubes lead into collecting vessels and the lower collecting vessel is filled partially with a liquid which fills the spiral tubes and partially with an inert gas under superatmospheric pressure for maintaining the liquid level in the spiral tubes. (Gmelin Inst.)

28707 LATCH COUPLING FOR THE CONNECTION OF A CONTROL ROD MOVING IN A GUIDE TUBE FOR NUCLEAR REACTORS WITH A HOLLOW DRIVE SHAFT. Kmonk, Stanley; Widmer, Thomas F. (to Westinghouse Electric Corp.). German Patent 1,207,026. Dec. 16, 1965. Priority date Nov. 16, 1961, United States.

The coupling mechanism comprises a hollow actuating rod secured to the lower end of a control rod through a latch mechanism which is supported at the lower end of the control rod. The latch mechanism releases the control rod automatically in the shutdown position so that the control can be removed from above the core by a loading machine. (Gmelin Inst.)

28708 DEVICE FOR SHUTDOWN OF NUCLEAR REACTORS. Dosch, Peter (to Gesellschaft fuer Kernforschung mbH). German Patent 1,207,521. Dec. 23, 1965. Filed Nov. 3, 1962.

The device for the shutdown of nuclear reactors by means of safety elements according to patent 1,151,885, comprising an electromagnetic collision-momentum-generating device and an electromagnetic-holding device is improved in that the holding device and the collision momentum generating device are combined in such a manner that they have a common magnetic circuit. (Gmelin Inst.)

28709 CONTROL AND SHUTDOWN ELEMENT FOR A NUCLEAR REACTOR. Janner, Karl (to Siemens-Schuckertwerke AG). German Patent 1,207,522. Dec. 23, 1965. Filed Mar. 21, 1959.

The control and shutdown device comprises a neutron absorbing member and a further member covering the latter, the absorber member having zones of absorber material alternating, as seen in the direction of movement, with zones that are free from absorber material, while said further member is adjacent to, but spaced from, the absorber member and has zones of fissionable material or reflector material alternating with zones free from such material, the alternations on the further member having a pitch equal to that of the alternations on the absorber member. The device also includes means for effecting relative movement between the two members. (Gmelin Inst.)

28710 SAFETY DEVICE FOR THE PRESSURE SHELL OF A NUCLEAR REACTOR. Kornbichler, Heinz (to Licentia Patent-Verwaltungs-GmbH). German Patent 1,208,017. Dec. 30, 1965. Filed Apr. 13, 1960.

To obtain a vapor suppression containment a water-cooled nuclear reactor is accommodated within a containment vessel divided by a partition into an upper and lower compartment in such a way that the reactor is situated in the lower compartment. The partition has a plurality of bores which are normally closed by closure means that prevent the water from partially filling the upper compartment and supported by the partition from entering the lower com-

partment, but permit steam to pass through the bores into the upper compartment in the event of a rupture in the reactor cooling circuit with a consequent increase of the pressure in the upper compartment. (Gmelin Inst.)

28711 ARRANGEMENT FOR PRESSURE-TIGHT JOINING OF EXCHANGEABLE PRESSURE TUBES IN AN ATOMIC REACTOR VESSEL. Kumpf, Hermann; Michael, Horst (to Siemens-Schuckertwerke AG). German Patent 1,208,423. Jan. 5, 1966. Filed Apr. 11, 1961.

A pressure tube connection in a nuclear reactor is given, which provides the tight connection of a pressure tube and a feed pipe stationary mounted at the base of the core, and which is demountable from above by means of a remote handling equipment (loading machine). A tubular, hollow tightening nut screwed onto the fixed pipe is provided on one side with an external thread and on the other with an outer engaging flange. A screw tool carried by a loading machine engages the radial serrations of the tightening nut flange and keeps off the torsional moment generated during screwing from the fixed feed pipe. (Gmelin Inst.)

28712 CONTROL MEANS FOR NUCLEAR REACTORS. Taylor, Anthony James; Peters, Martin Charles (to Deutsche Babcock and Wilcox-Dampfkessel-Werke AG). German Patent 1,208,834. Jan. 13, 1966. Filed Feb. 27, 1963.

The control means comprise a plurality of tubes positioned vertically in and extending above the core wherein balls of neutron-absorbing material are arranged in a single row which is freely movable along the tubes under the influence of fluid flowing therethrough, control means being arranged to vary the flow of fluid through the tubes. The cross section of the tubes increases progressively from the lower end, the profile being preferably conical or stepped. (Gmelin Inst.)

28713 DEVICE FOR FIXING THE BASE OF A FUEL ELEMENT IN THE SUPPORT GRID OF A NUCLEAR REACTOR. Chameroy, Jean; Gruel, Jean (to Commissariat a l'Energie Atomique). German Patent 1,213,065. Mar. 24, 1966. Priority date Nov. 5, 1962, France.

The device comprises a membrane which may be deformed and constitutes a part of the wall of a hole provided in the grid and into which the bottom of the fuel element to be locked is inserted. The membrane is deformed by the pressure exerted by a fluid in order to be maintained in contact with the bottom of the fuel element which is then locked. The membrane is disposed in an annular housing provided in the wall of the grid hole. (Gmelin Inst.)

Criticality Studies

28714 (BNWL-SA-616) SENSITIVITY OF THERMAL REACTOR PARAMETERS TO SCATTERING MODEL. Worden, J. R.; Purcell, W. L.; Liikala, R. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 25, 1966. Contract AT(45-1)-1830. 7p. (CONF-660303-31). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From American Physical Society, Conference on Neutron Cross Section Technology, Washington, D. C.

Comparative studies were carried out to determine the effect of the choice of scattering model for the common moderating materials, H_2O, D_2O, and graphite, on calculated reactor parameters. Calculations of the thermal reproduction factor, $\overline{\eta}$, and the thermal utilization, f, were made for uranium and/or plutonium for which measured values of parameters are available. The calculations were performed using the thermalization code, THERMOS, in conjunction with kernels generated using various scattering models. It is concluded that scattering in graphite is adequately represented by the Parks' kernel if the criterion for adequacy is matching the core parameters, $\overline{\eta}$ and f. This has been confirmed for systems containing uranium only and both uranium and plutonium where, in each case, calculated values of the parameters agree with those measured within the experimental uncertainty. The inadequacy of the free gas model for graphite is exhibited by discrepancies of 1 to 2 percent in the calculated value of f. It is shown that neglecting anisotropic scattering in H_2O leads to large errors in calculated parameters. Results of the study of scattering in D_2O are not conclusive and indicate the need for further study of simpler systems. (auth)

28715 (DP-1027) USER'S MANUAL FOR SRL-HERESY I. HETEROGENEOUS REACTOR SYSTEMS CODE FOR THE IBM 704. Finch, Donald R. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Mar. 1966. Contract AT(07-2)-1. 122p. Dep. mn. CFSTI $4.00 cy, $0.75 mn.

A detailed description of the SRL–HERESY I code (a production version of the HERESY I code developed by C. N. Klahr) is presented in a manner primarily intended for the user of the code. The heterogeneous reactor theory on which the code is based is developed briefly and followed by detailed coding information. Methods are given for solving finite or semi-infinite lattices containing up to 6500 lattice assemblies of up to 50 different types with unique geometrical or flux symmetry properties. Special techniques used with reflected reactor lattices are also described. Several examples of computations are presented as aids in testing and using the code. Detailed descriptions of programming and operating procedures are presented as appendices. (auth)

28716 (EURAEC-1523) THE STEADY-STATE AND DYNAMIC BEHAVIOUR OF A BOILING WATER REACTOR. Quarterly Progress Report No. 18, April 1, 1965–July 1, 1965. (Technische Hogeschool, Eindhoven (Netherlands)). July 1965. Contract 030-64-1-TEEN. 22p. (EUR-2675; WWO-16-R88). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

In this quarter the analysis of the measurements obtained during steady state conditions and by transfer function measurements, was started. Using the physical quantities measured in stationary conditions the slip factor and two phase friction multiplier were plotted as a function of different parameters. With respect to the slip factor the way of plotting as proposed by Zuber appears to be very promising. A series of transfer function measurements were carried out which mainly were taken between the power and a number of different quantities as for instance flow rate, void fraction and absolute pressure. The measurements were preceded by transfer function measurements of all measuring channels, the sensors included. These sensors appear to necessitate quite small corrections or no corrections at all with respect to the measured transfer functions from power to the physical quantities. The digital programming of the Jahnberg model was completed. A difficulty was still caused by the incompressibility of the system that Jahnberg assumes, but it was solved. A number of calculations was carried out in which the onset of instabilities as a function of power was approximated as close as possible and also the way, in which the different parameters varied with time and with the axial distance from the bottom was determined. The powers at the onset of instabilities seem to be far too low as compared with the ones experimentally obtained. For application in the linearized model the subcooled boiling model of Bowring was somewhat changed, however without changing the base of his study. (auth)

28717 (INR-471/IX-A) MIGRATION PARAMETERS OF THE UNLOADED ANNA ASSEMBLY. Bednarz, Roman; Dabrowski, Cyryl; Kaczmarek, Wlodzimierz; Malewski, Stefan; Szechter, Andrzej (Institute of Nuclear Research, Warsaw (Poland)). Nov. 1963. 13p. Dep. mn.

An attempt was made to determine some of the neutron migration parameters of the unloaded Anna assembly by measuring neutron density distributions induced by a Ra-α-Be neutron source. Diffusion length was estimated by means of an analysis of neutron density balance in small regions. In the core, it amounts to 16.2 cm in the direction perpendicular, to the fuel channels; the diffusion length value for the reflector is 43.4 cm. (auth)

28718 (JAERI–1105) EPSILON—AN IBM-7090 CODE FOR COMPUTING FAST FISSION EFFECTS IN LATTICE BY COLLISION PROBABILITY METHOD. Komatsu, Ichiro; Fukai, Yuzo (Japan Atomic Energy Research Inst., Tokyo). Mar. 1966. 26p. Dep. mn.

The fast fission effects in the multi-region lattices of cylindrical rods and slabs are calculated, using the collision probability method for the spatial problem and the multi-group technique. The content of the EPSILON code for calculation of the fast fission effects by the IBM-7090 is described. The EPSILON code has a maximum number of 5 regions in the lattices, including a maximum number of 2 fuel regions, a maximum number of 100 energy groups, and a maximum number of 10 elements in one region. The computing time is about 3 minutes when the number of energy groups is 18, the region number is 5 and the element number in the cylindrical rod lattice is 10. The calculation method for the fast fission effects is first given, then, the collision probabilities used in the EPSILON code are discussed, and the content of the code is last described. In an Appendix, the EPSILON-LT code for making a library tape of the EPSILON is described. (auth)

28719 (JAERI-Memo-2190) SOME ASPECTS OF THE THEORY OF NEUTRON FLUCTUATIONS IN A ZERO POWER REACTOR. Saito, Kelichi; Otsuka, MasuhiKo (Japan Atomic Energy Research Inst., Tokyo). Jan. 1966. 39p. (CONF-660206–12). Dep. mn.

From Symposium on Neutron Noise, Waves, and Pulse Propagation, Gainesville, Fla.

A generalized space-dependent formula for the noise analysis was developed. A generalized space-dependent formula for the pile modulation response is described. The space effects on the reactor noise, if it is measured, can be regarded as mixed ones originating from the following two facts: First, since there is the chain-related correlated noise source in a multiplying medium, the magnitude of fluctuations is not proportional to the detector volume even if the average number of neutrons is uniformly distributed over the phase space. Secondly, since the actual reactor is of finite extent, the system has not necessarily the translational and rotational invariance. The first effects are demonstrated using an infinitely large reactor model. An approximate model for treating the energy effects is presented. The one-group diffusion model is examined whether the square modulus of the sinusoidal pile modulation agrees, as in a point-reactor model with the power spectral density of the reactor noise. (M.O.W.)

28720 (WAPD-TM–424) SPARK: A FORTRAN IV DIGITAL PROGRAM FOR SUB-POWER ANALYSIS OF REACTOR KINETICS TRANSIENTS. Clarke, W. G. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Apr. 1966. Contract AT(11-1)-Gen-14. 74p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

A description is given of a FORTRAN IV digital computer program which numerically solves the conventional point reactor kinetics equations for transients with no feedback reactivity mechanisms. The program is especially useful in describing the dynamic behavior of the first (point kinetics) and second moments (stochastic process) of the neutron population in a reactor during startup from source and intermediate ranges. Special features of the program include simulation of nuclear instrumentation, analysis of intermediate range rate protection, gravity scram, and permissible time variation of basic kinetics parameters. (auth)

28721 MINIMUM CRITICAL MASS FOR LIMITED URANIUM CONCENTRATIONS. Kochurov, B. P. At. Energ. (USSR), 20: 243-7(Mar. 1966). (In Russian).

The minimum critical mass for limited uranium concentrations was studied. It was found that the optimum system is a three-zone system. Results were obtained for both plane and spherical geometries. (D.C.W.)

28722 MEASUREMENT OF RESONANCE NEUTRON FLUX IN NATURAL URANIUM–LIGHT WATER EXPONENTIAL ASSEMBLY. Yamamuro, Nobuhiro; Arai, Eiichi; Inaba, Gozo; Aizawa, Otohiko. Bull. Tokyo Inst. Technol., No. 69, 1-10(1965).

The resonance neutron flux in a natural uranium-light water system was studied by means of the resonance activation techniques. The spatial variations of the resonance neutron flux in a unit cell were measured at several energy points in the epithermal region from 1.46 to 340 ev. The experimental results of the flux depression in the fuel are in good agreement with the calculated value by a theory of Kushneriuk. (auth)

28723 ON THE DETERMINATION OF MICROSCOPIC REACTOR PARAMETERS USING AN EXPONENTIAL ASSEMBLY. V. Kleijn, H. R. (Reactor Instituut, Delft, Netherlands. Koninkl. Ned. Akad. Wetensch., Proc., Ser. B, 69: 155-71(1966).

The determination of the resonance escape probability for a reactor is discussed. This discussion includes experimental methods for this determination, detection methods for fission and neutron capture in uranium-238, and experimental equipment. (J.F.P.)

28724 ON THE DETERMINATION OF MICROSCOPIC REACTOR PARAMETERS USING AN EXPONENTIAL ASSEMBLY. VI. Kleijn, H. R. (Reactor Instituut, Delft, Netherlands). Koninkl. Ned. Akad. Wetensch., Proc., Ser. B, 69: 172-86(1966).

The experimental work for the determination of the conversion ratio is discussed. The counting results of the spatial fission density measurements for the central zone and for the peripheral zone are plotted, and the distribution of neutron absorption in uranium-238 in a fuel rod for various moderator void fractions are shown. The experimentally and theoretically determined resonance escape probabilities are given as a function of the moderator void fraction. The sub-calculations and parameters used for the engineering calculation of the resonance escape probability are listed. (J.F.P.)

28725 ON THE DETERMINATION OF MICROSCOPIC REACTOR PARAMETERS USING AN EXPONENTIAL ASSEMBLY. VII. Kleijn, H. R. (Reactor Instiuut, Delft, Netherlands). Koninkl. Ned. Akad. Wetensch., Proc., Ser. B, 69: 187-200(1966).

The determination of the thermal utilization factor is considered. Theoretical and experimental methods are discussed. Experimental equipment and procedures are described. (J.F.P.)

28726 ON THE DETERMINATION OF MICROSCOPIC REACTOR PARAMETERS USING AN EXPONENTIAL ASSEMBLY. VIII. Kleijn, H. R. (Reactor Instituut, Delft, Netherlands). Koninkl. Ned. Akad. Wetensch., Proc., Ser. B, 69: 201-22(1966).

A theoretical and experimental determination of the thermal utilization factor is presented. The measured and calculated thermal neutron density distribution in a unit cell for zero and maximum obtainable void percentages, and the thermal utilization factors as a function of the moderator void fraction are shown. The product of the resonance escape probability and the thermal utilization factor is also shown as a function of moderator void fraction. (J.F.P.)

Design and Feasibility

28727 BOILING-WATER REACTOR WITH STEAM-WATER SEPARATORS INSIDE THE REACTOR PRESSURE VESSEL. Kornbichler, Heinz (to Licentia Patent-Verwaltungs-GmbH). German Patent 1,208,833. Jan. 13, 1966. Filed Sept. 23, 1960.

The boiling-water reactor comprises a pressure vessel containing the core, a plurality of vertical, parallel chimneys extending upward from the core in which a mixture of steam and water flows from the core upwards, and a plurality of water-from-steam separators provided at the upper end of each chimney and disposed in series relation. Each of the separators has a steam-delivery pipe which ends above the water level in the pressure vessel, the water

level being maintained above the uppermost separator. (Gmelin Inst.)

28728 PRESSURIZED WATER REACTOR PLANT. Bogaardt, Maarten; Bonsel, Wouter Gouke; Muysken, Matthijs; Wijnandus, Wilhelmus; Bahbout, Abraham (to Reactor Centrum Nederland). German Patent 1,213,067. Mar. 24, 1966. Priority date Jan. 26, 1961, Netherlands.

A pressurized water nuclear reactor plant in which the water acts both as coolant and moderator, comprises a casing enclosing a reactor core, a heat exchanger, a pump for circulating water through the core and heat exchanger in series, at least one jet pump within the casing by the action of which a portion of the water inside the casing is recirculated through the core by way of the space provided at the sides of the core. The ratio of the quantity of water flowing through the core to the quantity of water flowing out of the casing to the heat exchanger is between 1.5 and 4 when the reactor is at full load. (Gmelin Inst.)

28729 FAST BREEDER NEUTRONIC REACTOR. Tower, Stephen N. (to Westinghouse Electric Corp.). U. S. Patent 3,244,597. Apr. 5, 1966. Filed Dec. 14, 1962.

A fast breeder, liquid metal cooled reactor is described that employs a novel pebble-bed core. The core structure is positioned generally within the reactor, and a quantity of discrete fuel pellets is contained loosely within the core structure in a dispersed non-critical array. Physically spaced means are provided for holding the fuel pellets in this non-critical array, and means are provided for moving the pellets from this non-critical arrangement into a more closely packed arrangement that results in sufficient close packing to sustain a fast chain reaction. The non-moderating coolant is circulated through the core with such force that the coolant flow through the core gathers the pellets into the closely packed arrangement necessary for the chain reaction. In case of reduction of coolant flow, whether intentional or accidental, the pellets will again settle by gravity into their non-critical array and terminate the chain reaction to shut down the reactor. Means are also provided whereby the reactor can burn its own bred fuel without the necessity of intermediately processing the fuel. (B.L.M.)

Fuels

Refer also to abstract 27785.

28730 (GAMD–6525) A COMPARISON OF THE HEXAGONAL BLOCK FUEL ELEMENT AND ANNULAR FUEL BED CYLINDRICAL FUEL ELEMENT PERFORMANCE CHARACTERISTICS. Winkler, E. O.; Nehrig, D. A.; Leon, H. I. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Dec. 16, 1965. Contract AT(04-3)-167. 70p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

The thermal, mechanical, and irradiation contraction performance characteristics of hexagonal block fuel elements were compared with those of cylindrical fuel elements. A short summary on the qualitative results of a single column vibration stability test is also included. A brief discussion is presented on graphite materials which might be considered for the hexagonal block fuel element. Preliminary work was done on the associated problems of fuel handling of the hexagonal fuel element. The results are discussed. (M.O.W.)

28731 (GEAP–4770) A TECHNICAL AND ECONOMIC EVALUATION OF VENTED FUEL FOR SODIUM-COOLED FAST CERAMIC REACTORS. O'Neill, G. L.; Duffy, J.; Sherer, D. B.; Gilbertson, J. C.; Knight, F. W. (General Electric Co., San Jose, Calif. Advanced Products Operation). May 1965. Contract AT(04-3)-189. 169p. Dep. mn. CFSTI $5.00 cy, $1.00 mn.

A comparative analysis was made of the effect of the vented-to-coolant fuel design versus the vented-to-plenum fuel design upon the operating safety and the capital and operating costs of a fast, ceramic-fueled reactor (FCR). A successful test of a simple venting device which appears to accomplish several technical objectives is described. The device relieves the fission gas pressure stress on the fuel cladding, provides sufficient gas holdup time to retain the more noxious fission products in the fuel element, and prevents ingress of liquid sodium. Specifically, no measurable, significant quantity of solid fission products, solid activation products, or fissile material escapes through the vent. The only significant activity in the coolant (other than Na activity) was ^{134}Cs, an activation product of ^{133}Cs, the daughter of the gas ^{133}Xe, which had escaped the vent. The analysis is largely directed at the more obvious parts of the primary system involved; namely, the cover gas system, the shielding, and the cladding. In addition, the problems of operating safety, gas de-entrainment from the coolant, pumping requirements, vessel and building size, fuel handling, spent fuel shipment, and fuel reprocessing were considered. It is concluded that vented-to-coolant fuel design has good potential and may be the preferred concept, although further tests are necessary to confirm the preliminary results. (auth)

28732 (GEAP–4819) EXPERIMENTAL STUDIES OF TRANSIENT EFFECTS IN FAST REACTOR FUELS. SERIES III. PRE-IRRADIATED MIXED OXIDE (PuO_2–UO_2) IRRADIATIONS. INTERIM REPORT. STEADY-STATE IRRADIATIONS. Hanson, J. E.; Rabin, S. A. (General Electric Co., San Jose, Calif. Advanced Products Operations). Sept. 1965. Contract AT(04-3)-189. 135p. Dep. mn. CFSTI $4.00 cy, $1.00 mn.

The irradiation performance of five 0.250-inch-diameter mixed oxide (PuO_2-UO_2) fuel specimens is presented and discussed. The burnup attained by two specimens was about 8000 MWd/T_e. The three remaining specimens attained goal exposures of about 65,000 MWd/T_e. One low burnup and one high burnup specimen were subjected to destructive examinations. The remaining specimens were examined by means of nondestructive techniques prior to a re-encapsulation for transient irradiation. (auth)

28733 (GEAP–4919) AEC FUEL CYCLE PROGRAM. Final Summary Report. Megerth, F. H.; Baroch, C. J.; Hoffmann, J. P.; Ogawa, S. Y.; Pashos, T. J.; Williamson, H. E. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Dec. 1965. Contract AT(04-3)-189. 49p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

The possibilities of extending the performance of UO_2 rod fuel in boiling water reactors were examined. Basic test fuel assemblies were fabricated utilizing commercial pellet-in-tube methods, irradiated in the VBWR, and examined. Specialized test assemblies were fabricated and tested to investigate the possibilities of increased fuel rod thermal output, alternate cladding materials and fabrication processes, and nuclear life extension. A summary of these efforts, discontinued because of reactor operation termination, is presented. (J.R.D.)

28734 PROSPECTS FOR PLUTONIUM RECYCLE. Nucleonics, 24: No. 5, 58-63(May 1966).

The prospects for recycling plutonium in thermal reactors are investigated for the economic utilization of plutonium generated in commercial reactors. Considerations on pressurized-water and boiling-water reactors are discussed. (L.B.S.)

28735 FUEL ELEMENT CANS FOR NUCLEAR REACTORS. Conway-Jones, Arthur Hugh (to English Electric Co. Ltd.). British Patent 1,025,703. Apr. 14, 1966. Filed Sept. 13, 1961.

A hollow core, generally cylindrical fuel can is provided with a number of helical fins on the outside to constitute an extended heat transfer surface. The fins extend in a direction having a longitudinal component with respect to the axis of the core, and the fins are so arranged that there is a circumferential variation in heat transfer coefficient between the can and the cooling fluid. The radial distance between the axis of the can and the outer edge of the fins varies from one fin to another over the circumference of the core along at least a part of the can. The outer edges of any cross section or any part of the cross section define a non-

circular boundary around the fins, thus tending to reduce the variation in heat transfer coefficient. If desired, the can may be provided with splitter fins, or the fins may take the form of parallel grooves in the surface of the can. (B.L.M.)

28736 GAS- AND LIQUID-TIGHT JOINING OF A FUEL TUBE WITH THE WALL OF A NUCLEAR REACTOR. Foulquier, Henri; Bridoux, Claude; Stohr, Jacques, Thome, Paul (to Commissariat a l'Energie Atomique). German Patent 1,208,422. Jan. 5, 1966. Priority date Mar. 1, 1960, France.

The central portion of the tube, having a better transparency to neutrons than steel, is jointed to a sleeve portion in a fluid-tight manner, the sleeve portion being welded to a core part. The jointing of the sleeve portion to the central portion is effected by screwing together complementary threads provided on the two portions to be jointed, the fluid-tight seal being completed at one end of the screwed threads. (Gmelin Inst.)

28737 FUEL ELEMENT FOR NUCLEAR REACTOR. Hildebrand, Gosta Erik (to Fulcrum Aktiebolag). U. S. Patent 3,244,599. Apr. 5, 1966. Filed May 28, 1962.

A multiregion fuel element provided for nuclear reactions has a central core containing fissile material in a form capable of withstanding comparatively high temperatures prevailing in the central part of the fuel element and an outer mantle of fissile material having physical properties different from those of the core material and a comparatively higher heat transfer capability. The mantle is spaced from the outer walls of the core by an intermediate layer of non-fissile material that may be either gas, solid, or liquid, that has a low neutron absorption cross section, that is substantially inert to the materials of both the core and of the mantle, and that facilitates removal and distribution of heat. Suitable materials for the core are oxides, carbides, silicides, nitrides, borides, sulfides, or like of suitable fissile metals, either alone or mixed with a suitable metal in order to increase the heat conductivity and the mechanical stability. The preferred material is UO_2, either in powder or compacted form. The mantle may consist of either metallic U or Pu alone, alloyed with a suitable metal, or bonded to a suitable non-fissile material. The entire element may be provided with a conventional cladding that may also be finned. (B.L.M.)

Power and Power-Breeder Reactors

Refer also to abstract 27787.

28738 (AECL–2534) TRENDS IN ATOMIC POWER COSTS. Haywood, L. R. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Mar. 1966. 18p. (CONF-660205–5). Dep. mn. AECL $1.00.

From Metallurgical Society of the American Institute of Mining, Metallurgical, and Petroleum Engineers, New York.

Reported actual and estimated unit capital costs for nuclear plants in Canada, France, United Kingdom and the United States are normalized to costs for single 500 MW(e) plants in 1966 dollars. It is thus possible to determine cost trends excluding the effect of unit size and escalation. The reported plant efficiencies plus a factor which relates change in unit cost to change in efficiency permits the determination of the effect of increasing efficiency on unit cost. Various factors are proposed which will reduce the cost of energy from CANDU nuclear plants, and the contribution of each of these factors to this reduction is calculated for a particular case. The cost of energy from a 1000 MW(e) CANDU unit is predicted assuming the cost reduction factors proposed and commissioning of the unit in 1976. (auth)

28739 (AI-CE–15) HEAVY WATER ORGANIC COOLED REACTOR. PHYSICAL PROPERTIES OF SOME POLYPHENYL COOLANTS. Mandel, H. (Atomics International, Canoga Park, Calif. Combustion Engineering, Inc., Windsor, Conn. Nuclear Div.). Apr. 15, 1966. Contract AT(38-1)-430. 46p. Dep. mn. CFSTI $3.00 cy, $0.50 mn.

The physical properties of polyphenyl HWOCR coolant candidates are summarized and reviewed. Data are included on properties such as density, viscosity, specific heat, thermal conductivity, vapor pressure, melting point and heat of fusion, and flammability. Recommendations are made for additional physical properties investigations in cases where data are lacking or additional data are considered necessary. (auth)

28740 (BAW–393-4) THORIUM FUEL CYCLE FOR HEAVY WATER MODERATED ORGANIC COOLED REACTORS. Technical Progress Report No. 3, July–December 1965. (Babcock and Wilcox Co., Lynchburg, Va. Atomic Energy Div.). Contract AT(38-1)-393. 284p. Dep. mn. CFSTI $6.00 cy, $1.50 mn.

The long-range objective of the Th fuel cycle development is the proof of performance of Th fuel elements in an HWOCR environment. The primary effort during the period was related to the selection of a Th fuel element for future development. Types of fuel elements studied in detail include the metal nested cylinders, ThO_2 clustered pins, and ThC_2 clustered pins. The economics and fuel utilization of these fuel element types were evaluated for use in a 1000 Mw(e) Th-optimized HWOCR. Performance and cost trends were established to guide further design optimization leading to the selection of a fuel element for a future test program. (auth)

28741 (EURAEC–1613) MEASUREMENT OF THE POWER DISTRIBUTION IN THE GARIGLIANO BOILING WATER REACTOR BY A NEW METHOD OF GAMMA SCANNING OF THE FUEL ELEMENTS. Special Report No. 1. (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). Mar. 1966. 101p. Dep. mn. CFSTI $4.00 cy, $0.75 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

At the end of the first period of operation of the Garigliano power station, when the reactor was shutdown according to schedule, a gamma scanning measurement was carried out on selected fuel elements. The measurement in involved the use of a new method based on the monitoring of the neutrons generated by the (γ,n) reaction in D_2O. This reaction, which has a threshold of 2.2 Mev, allows of selecting the gamma rays of higher energy (2.55 Mev) emitted by ^{140}La. Results of the analysis are compared with earlier data. (M.O.W.)

28742 (GA–6418) TARGET—A PROGRAM FOR A 1000-Mw(e) HIGH-TEMPERATURE GAS-COOLED REACTOR. Quarterly Progress Report for the Period Ending May 31, 1965. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). June 30, 1965. Contract AT(04-3)-167. 178p. Dep. mn. CFSTI $5.00 cy, $1.00 mn.

Efforts devoted to fuel development are reported in the areas of mechanical design, materials technology, fission product behavior, GAIL loop operation, recycle technology, and reactor core analyses. Development and analysis of prestressed concrete reactor vessels are summarized. (J.R.D.)

28743 (GA–6671) HTGR BASE PROGRAM. Quarterly Progress Report for the Period Ending August 31, 1965. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Sept. 30, 1965. Contract AT(04-3)-167. 111p. Dep. mn. CFSTI $4.00 cy, $0.75 mn.

Activities in a program directed toward design and development of a 1000-Mw(e) gas-cooled reactor are reported. Progress is summarized on development of prestressed concrete reactor vessels, in-pile loop testing, reactor physics methods development, fuel recycle studies, and design of advanced fuels. (J.R.D.)

28744 (GA–6869) HTGR BASE PROGRAM. Quarterly Progress Report for the Period Ending November 30,

1965. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Jan. 15, 1966. Contract AT(04-3)-167. 67p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Further developments are reported on each of the following research tasks: (1) prestressed concrete reactor vessel, (2) methods development, (3) General Atomic in-pile loop (GAIL), (4) reactor physics, (5) recycle studies, and (6) advanced fuels. Fission product release, transport, and deposition data taken in GAIL are reported. Irradiation tests on advanced fuels were completed. The results are included. (M.O.W.)

28745 (GA–7038) EBOR CONTROL ROD DRIVE DEVELOPMENT PROGRAM. An Interim Report. Anderson, J. K.; Furgerson, W. T.; Wellhouser, H. N. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Mar. 23, 1966. Contract AT(04-3)-187. 129p. Dep. mn. CFSTI $4.00 cy, $0.75 mn.

During the course of development of the control rod drive mechanisms for the Experimental Beryllium Oxide Reactor (EBOR) a number of difficulties were encountered. The development work over the past several months describing the two-phase approach instituted in March 1965 is summarized. The two-phase approach proposes delivery of a low-temperature mechanism for initial fuel loading and zero power testing as Phase I and a modified mechanism suitable for long term operation at high temperature in helium as Phase II. The Phase I production prototype mechanism successfully completed life-cycle testing. The life cycle is described and the test results are discussed in detail. Development work on the Phase II mechanism is directed toward utilizing as much of the Phase I mechanism as possible. This work has progressed to the point where it is now concluded that the Phase I drive should be modified to incorporate a gravity rather than a power scram system for the Phase II mechanism. The other major decision, whether or not to retain the present planetary reduction gear system on the positioning motor, is being reserved until the current test program is completed. Alternates to this design are briefly described. (auth)

28746 (GEAP–4795) SODIUM-COOLED REACTORS PROGRAM. FAST CERAMIC REACTOR DEVELOPMENT PROGRAM. Quarterly Report No. 13, October 1964–January 1965. Breizy, C. E. (ed.) (General Electric Co., San Jose, Calif. Advanced Products Operation). Contract AT(04-3)-189. 92p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Three high-power capsules were irradiated at 27, 31, and 35 kW/ft. The degree of melting and slumping of molten fuel varied from negligible at 27 kW/ft to substantial at 35 kW/ft. Ex-reactor mockups of the B3B convection circulating irradiation capsule have supplied empirical data for design of the in-reactor capsule. The inert atmosphere facility for performing sodium-fuel compatibility studies was completely installed and proof-checked. The Series 2 transient irradiations (0.250-inch diameter, non-pre-irradiated, 20 wt % PuO_2 – 80 wt % UO_2) were completed. Preparations for the transient irradiation of the first pre-irradiated mixed oxide specimen (Capsule C3B, ~7000 MWD/MT) continued. Detailed examination of Capsule E1A was completed. The in-pile fuel center temperature and gas bulb data from this capsule provide the first direct in-pile thermal conductivity measurement of 20 wt % PuO_2 – 80 wt % UO_2 fuel and comparison with UO_2-only fuel. The derived conductivity for mixed oxide is somewhat lower than for UO_2, especially at lower temperatures. Gap conductivity trends for UO_2 and for mixed oxides was determined as a function of power and time in-pile. Axial fuel redistribution was found to be significantly less in mixed oxides than in UO_2 at identical power levels. An experiment to measure in-pile gap conductivity for various initial gaps (capsule E1B) was designed. Detailed examination of Capsules E2A and E2B was completed. A topical report for Capsule E2B (70,000 MWD/MT) has been completed. The preliminary design of the high burnup capsules (E2C-E2D) was completed and detailed design is scheduled for completion in April. An experiment to provide unambiguous fuel swelling data at high burnups (E2E) was scoped. A NaK-fuel reaction product was observed during the RML examination of Capsule E3A. The reaction product occurred for all three fuel stoichiometries tested. Different patterns of radial alpha emitter concentration were found for each stoichiometry. The micro-core and linear micro-sampling systems were installed and checked out in the alpha-beta-gamma hot cell. Out-of-pile thermal conductivity of $UO_{2.00}$, $UO_{1.97}$, $UO_{1.98}$, was measured, and also mixed oxides 20:80 $(Pu,U)O_{1.97}$, 20:80$(Pu,U)O_{2.00}$ and 20:80$(Pu,U)O_{2.04}$. The data for $UO_{2.00}$ is in good agreement with in-pile thermal conductivity measurements. Conductivity data on the mixed oxides indicates a lower conductivity than UO_2 at low temperatures. Measurements of electrical resistivity and thermoelectric power on mixed oxides established the relationship between stoichiometry, plutonia content, and the intrinsic electric properties. These results provide the basis for a convenient nondestructive method for identification of stoichiometry of mixed-oxide pellets. Sintering studies were initiated to establish reproducible pellet fabrication techniques for making intermediate density pellets for comparison irradiations with compacted fuel. Radiographic examination of Group 1 and 2 capsules showed the presence of a void in the sodium below the specimen in every capsule. Centrifugation and controlled heating and cooling were successful in eliminating the voids when several vibratory techniques were unsuccessful. The centrifuge facilities at Sandia Corp. are being used to treat the capsules in Groups 1 and 2. A more accurate equation for calculating the one-dimensional geometric bucklings was developed and incorporated into the one-dimensional reactor code, MISY. Specification of the equations for the FORE II transient code was virtually completed. A study of the energy release in core compaction accidents was completed using both cylindrical and spherical core models in the Bethe-Tait method of analysis and examining the effects of Doppler coefficient, equation of state, and other variables. The nickel (n,p) and iron isotope (n,p) cross sections were evaluated and incorporated into the current cross section file. Four annular cores were studied and partially evaluated by comparing aspects of their performance with the pancake 1000 MW(e) reference design. The annular cores indicate improved breeding ratios and sodium voidage effects that justify further study of this design. A study of the reactivity worth of beryllium reflector elements indicates a potential for reactor control using these elements. (auth)

28747 (GEAP–4860) SODIUM-COOLED REACTORS PROGRAM. FAST CERAMIC REACTOR DEVELOPMENT PROGRAM. Quarterly Report No. 14, February–April 1965. Breizy, C. E. (ed.) (General Electric Co., San Jose, Calif. Advanced Products Operation). May 1965. Contract AT(04-3)-189. 76p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Fabrication is in progress on two capsules for the investigation of fission-product plugging. The capsules incorporate convection circulation design features checked out in ex-reactor mockup tests. Detailed design of the capsule for in-reactor sodium-compatibility test was also completed and fabrication is underway. Transient irradiation of the first pre-irradiated mixed-oxide specimen (C3B, ~7000 MWD/MT) was completed and post-irradiation examination was started. Preparations for the transient irradiation of the first burnup (~60,000 MWD/MT) mixed oxide specimen were continued. Conceptual planning of experiments to investigate the performance of axially restrained fuel was conducted. Some prospective alternate transient irradiation facilities were evaluated. Detailed examination of the metallographic and thermocouple data from Capsule E1A was completed. Two short-time, high power capsules (E1C and E1D) were designed and fabricated to establish the relative smeared thermal conductivity of 20 wt % PuO_2 – 80 wt % UO_2 as a function of stoichiometry; using O/M ratios of 1.98 and 2.00 and also $UO_{2.00}$. These capsules will be operated at power levels slightly above center melting and conductivity will be inferred by establishing the relative molten boundaries. Two high-burnup, short-fuel-length capsules (E1E and E1F) were designed and are being fabricated to measure the relative conduc-

tivity and melting temperature of high burnup fuel. Detailed design of the high burnup capsules (E2C and E2D) was completed and fuel fabrication has started. The design of four high-burnup fuel-swelling capsules (E2E, F, G, and H) was also completed. Definite indication of radial migration of plutonium was observed by mass spectrometric analysis of samples removed from E3A at selected radial fuel cross sections. These results are consistent with those observed by alpha autoradiography which show a different pattern of plutonium distribution for each stoichiometry. Additional tests on conductivity of mixed oxide fuel were made which confirm a different dependence on stoichiometry relative to UO_2. The irradiation subassembly containing Group 1 capsules was loaded for an expected 8-day irradiation in the EBR-II core beginning May 10th. Rework of Group 2 capsules was successful in removing bubbles and voids from the sodium annulus. The capsule internal design and sodium-filling procedure were modified to avoid such bubble formation in future encapsulations. A study is being conducted of various pancake-shaped reactors. The calculated results of varying reactor dimensions, core composition, and blanket composition will serve as a guide for evaluating the potential of the basic pancake core configuration. Investigation of a fuel management pattern involving spatially distributing the isotopic plutonium composition indicates that the maximum reactivity input for a partial sodium loss can be reduced by a factor of two in a pancake-shaped core, but with attendant economic penalties. The current cross section file is being updated by comparing it with other files. In addition to providing a basis for correcting the cross-section file, the comparison is used to determine the degree of uncertainty in reactor physics calculations. (auth)

28748 (GEAP-4931) SODIUM-COOLED REACTORS PROGRAM. FAST CERAMIC REACTOR DEVELOPMENT PROGRAM. Fifteenth Quarterly Report, May–July 1965. Breizy, C. E. (comp.) (General Electric Co., San Jose, Calif. Advanced Products Operation). Aug. 1965. Contract AT(04-3)-189. 89p. Dep. mn. CFSTI $3.00 cy, $0.50 mn.

The thermal-hydraulic performance of the convection-circulating capsule design was demonstrated successfully in a full-power, ex-reactor mockup test. Fabrication of the first two capsules of this design is under way. Post transient irradiation examination of the low burnup specimen, C3B (7900 MWD/MT), was completed. An analytical model which describes the apparent fission gas behavior during a transient was derived from the results of the experiment. Neutron radiography of the high burnup specimen, C3E (63,000 MWD/MT), was completed and indicated only slight fuel relocation had occurred during the steady-state irradiation and no detectable cladding deformation. Transient irradiation of this specimen is being planned. A total of six fuel pins were fabricated and irradiated during this period. An additional 12 fuel pins were fabricated and irradiation is scheduled to begin during the next quarter. Capsule E1C was irradiated and examined. Two mixed-oxide fuel pins in this capsule were successfully irradiated for 5 hours at a power level of 46.6 ± 5 kW/ft. This test represents the highest known steady-state power level reported for mixed oxides. The results from this experiment indicate that the $\int_0^T m k d\theta$ for hypostoichiometric fuel is approximately 20 percent higher than the stoichiometric composition. Analysis of a NaK-mixed-oxide reaction product from Capsule E3A suggests that the O:M ratio of mixed oxides is significantly reduced in the presence of alkali metals at temperatures of 1000°C. Electron microscopy of low-, medium-, and high-burnup mixed oxides was completed showing gradual changes in microstructure as a function of burnup. X-ray diffraction studies showed that additions of oxygen to mixed oxides result in a linear decrease in the unit cell size with increased oxygen. Irradiation of the Group 1 fuel and materials specimens in EBR-II was completed. Exposure was at a calculated peak linear power of 16.4 kW/ft to a burnup of ~2000 MWD/MT. The nondestructive portion of the post-irradiation examination was completed, from which it appears that the fuel pins are in excellent condition. A two-zone core with variable BeO moderator was found to be a satisfactory technique for power flattening a 15-inch (height), pancake-shaped core. This concept reduced the peak-to-average power ratio from 1.9 for a one-zone core to 1.22. An evaluation of new cross section data indicates that changes in calculated physics parameters will be small. Evaluation of a thin, pancaked core with a large fuel volume indicates that both neutron economy and reactor safety can be obtained. The core geometry and composition criteria to be used were chosen: A height of 16.06 inches with an equivalent diameter of 11.28 feet; the average composition of this core at equilibrium is 38.57 percent fuel, 6.98 percent BeO 33.47 percent sodium, 20.31 percent steel, and 0.67 percent tantalum. (auth)

28749 (GEAP-5060) ACCURATE NUCLEAR FUEL BURNUP ANALYSES. Sixteenth Quarterly Progress Report, September 1965–November 1965. Rider, B. F.; Ruiz, C. P.; Peterson, J. P. Jr.; Smith, F. R. (General Electric Co., San Jose, Calif. Vallecitos Atomic Lab.). Dec. 1, 1965. Contract AT(04-3)-189. 29p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

During this quarter, the absolute ^{235}U thermal fission yields for stable neodymium isotopes were measured on a capsule containing a weighed amount of highly enriched ^{235}U and irradiated in the MTR for three cycles. The capsule was dissolved and analyzed for the amount of uranium remaining and the amount of each fission product isotope by isotopic dilution mass spectrometry. The fission yields for neodymium-143, -144, -145, -146, -148, and -150 were found to be 5.98, 5.29, 3.91, 2.95, 1.67, and 0.633%, respectively. The calculation and measurement of ^{236}Pu and ^{232}U concentration in irradiated UO_2 fuel as a function of fuel burnup was completed during the quarter. Concentrations of ^{232}U in irradiated UO_2 fuel exceed the AEC specified tolerance of 11 ppb of ^{235}U in a single fuel cycle in both Boiling Water Reactors (BWR) and Pressurized Water Reactors (PWR). To achieve the AEC-specified limit of 150 dis/min of Pu per gram of U, the reprocessing of 15 GWd/t fuel will have to achieve a plutonium decontamination factor in excess of 2×10^7. (auth)

28750 (GEAP-5061) EVESR NUCLEAR SUPERHEAT FUEL DEVELOPMENT PROJECT. Quarterly Report No. 14, September–November 1965. Roof, R. R. (General Electric Co., San Jose, Calif. Advanced Products Operation). Dec. 1965. Contract AT(04-3)-189. 88p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

During this period, the EVESR reactor operated normally at power levels of 15 to 17 Mw(t), except for a shutdown from September 12 to October 15 for installation of several new test facilities in the EVESR plant. During reactor operation, the Type-304 stainless-steel-clad Mark II fuel bundle, KB-29, continued to be the only bundle with any significant fission product release. The release consists of a steady emission of fission gases which does not significantly affect normal reactor operation. The radioactivity release from KB-29 differs from the radioactivity release experienced earlier with the failed fuel rod in Mark III bundle KB-41 in that no significant nonvolatile, particulate activity was measured from KB-29, and the total release rate is lower. The failed fuel rod with 0.008-inch Incoloy-800 cladding from the Mark III bundle KB-41 was examined. Examination of the thermal liners in fuel bundle KB-41 revealed that there was no damage to the liner associated with the fuel rod failure. Replacement fuel is being prepared for reconstituting bundle KB-41 for further irradiation in EVESR. Plans and designs were completed to irradiate a purposely-defected fuel rod in KB-41. This will permit measurement of radioactivity release and study of defect propagation starting with a defect of known configuration. Initial planning for the Mark V fuel design configurations and test variables was completed and preliminary drawings were issued for review. Irradiation of capsule SC-10, containing fuel cladding samples at 1100 to 1350°F, continued in GETR. Capsules MT-1 and MT-2, containing a total of 72 cladding specimens, are at ANL awaiting insertion in EBR-II. (M.O.W.)

28751 (GEAP-5125) EVESR NUCLEAR SUPERHEAT FUEL DEVELOPMENT PROJECT. Quarterly Report No. 15, December 1965–February 1966. Roof, R. R. (comp.) (General Electric Co., San Jose, Calif. Advanced Products Operation). Mar. 1966. Contract AT(04-3)-189. 108p. Dep. mn. CFSTI $4.00 cy, $0.75 mn.

During this period, operation of the ESADA-Vallecitos Experimental Superheat Reactor (EVESR) was continued in the full-power range of 15 to 17 Mw(t) in support of the Superheat Fuel Development Program. On January 5, 1966, a significant transient increase occurred in the radioactivity release from Mark II fuel bundle KB-11. During subsequent full-power operation, the steady-state release of radioactivity from KB-11 was only about one-quarter of that from KB-29, and it consisted primarily of volatile fission products. Fuel bundle KB-11 will be removed from the reactor during the planned reactor outage in March for examination of the apparent cladding defect. To obtain more experience on superheat fuel performance and radioactivity release when the fuel is operated with a known defect in the cladding, preparations were completed to install in EVESR a Mark III fuel rod having a defect in the cladding. The defect consists of a slot 0.080 × 2 inches long cut through the 0.020-inch-thick Incoloy-800 cladding. The defected fuel rod will be installed in EVESR during the March shutdown. Mark III fuel bundle KB-41, which was removed from the reactor in July 1965 to permit examination of a failed fuel rod, was reconstituted using two seven-rod clusters of new unirradiated fuel and two clusters of fuel previously irradiated in KB-41. The new fuel was supplied by the NSPE Project. The irradiated fuel has 0.008-inch-thick Incoloy-800 cladding. The availability of the new fuel clusters has made it possible to reassemble the bundle of four clusters and resume the irradiation of the fuel with 0.008-inch-thick cladding. Small, but potentially significant, quantities of lead were measured in the moderator and boiler water. The lead concentrations measured were less than 1 ppM. Lead in larger concentrations is reported to cause accelerated local corrosive attack in high-nickel alloys. Capsule irradiations of superheat fuel cladding material specimens continued in EBR-II and GETR as a basis for studying the effect of fast and thermal neutron irradiation on the mechanical properties of these materials. Capsule SC-10 continued irradiation in GETR and has received a peak exposure of approximately 1.1×10^{21} nvt (En ≥ 1 Mev). Capsules MT-3 and MT-4 were installed in the EBR-II core in December 1965, and are scheduled to receive an exposure of $>10^{22}$ nvt (En ≥ 1 Mev) during a 12-month period. (auth)

28752 (JUL-321-RG) DAS BRUTVERHALTEN EINES EPITHERMISCHEN SALZSCHMELZENREAKTORS. III. EXTERNE KUEHLUNG DURCH BLEI. (The Breeding Behavior of an Epithermal Molten Salt Reactor. III. External Cooling with Lead). Barthold, W. P.; Graf, I.; Wolf, L. A. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung). Nov. 1965. 145p. Dep. mn.

The breeding behavior of an epithermal molten salt reactor with an external lead cooling the MOSEL-II is described. The effect of the components of the molten salts and the effect of the size of the lattice on the breeding behavior and the multiplication time were determined. (tr-auth)

28753 (IDO-28655) ARMY GAS-COOLED REACTOR SYSTEMS PROGRAM. Final Report. (Aerojet-General Nucleonics, San Ramon, Calif.). Mar. 1966. Contract AT(10-1)-880. 238p. Dep. mn. CFSTI $6.00 cy, $1.25 mn.

The technical accomplishments under the Army Gas-Cooled Reactor Systems Program are summarized. A brief chronology of the evolution of the program, including the reactor development activity, the design, fabrication and subsequent testing of the ML-1 nuclear power plant and related activities are discussed. The summary is supplemented by a comprehensive bibliography which includes a brief abstract of each referenced report or document. (auth)

28754 (LA-DC-7753) THE IRRADIATION OF LIQUID PLUTONIUM FUELS IN A THERMAL REACTOR. Cubitt, R. L.; Ragan, G. L.; Kirkpatrick, D. C. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [1966]. Contract W-7405-eng-36. 28p. (CONF-660511-3). Dep. mn. CFSTI $2.00 cy, $0.50 mn.

From International Symposium on Capsule Irradiation Experiments, Pleasanton, Calif.

The in-pile irradiation program which has been in progress at the Los Alamos Scientific Laboratory (LASL) since January 1964 is described. The purpose of this program is to obtain preliminary irradiation data on the liquid plutonium alloy fuels and tantalum containers that will be used in the Fast Reactor Core Test Facility (FRCTF). Thus, the irradiations are performed under operating conditions and environment simulating those expected in the FRCTF; i.e., fuel-container interface temperatures are maintained above the fuel freezing point of approximately 440°C and below 725°C during all phases of reactor operation and shutdown. The irradiations are accomplished in LASL's 5.0 MW MTR-type reactor, the Omega West Reactor (OWR). The technique developed employs a natural convection sodium loop located in the OWR core where the fast and epithermal neutron flux components are highest. A tantalum fuel capsule containing 24 g of Pu–Co–Ce fuel (6.2 g Pu/cc) placed in the loop operates at an average specific power of 150 W/g plutonium. With the present reactor operating schedule, 1% burnup is achieved in about 10 weeks. (auth)

28755 (NP-15908(Exh.D)(Vol.1)(App.)) BROOKWOOD NUCLEAR STATION UNIT NO. 1. PRELIMINARY FACILITY DESCRIPTION AND SAFETY ANALYSIS REPORT. Introduction and General Summary. Description of Site and Environment. (Rochester Gas and Electric Corp., N. Y.). [nd]. 229p. (DOCKET-50-244(Exh.D)(Vol.1)(App.)). Dep. mn. CFSTI $6.00 cy, $1.25 mn.

The results of a detailed site evaluation study for the Brookwood Nuclear Power Reactor are presented. Geologic, hydrologic, seismologic, and foundation engineering studies are reported. (M.O.W.)

28756 (NP-15908(Exh.D)(Vol.2)(Pt.A)) BROOKWOOD NUCLEAR STATION UNIT NO. 1. PRELIMINARY FACILITY DESCRIPTION AND SAFETY ANALYSIS REPORT. Plant Design Description and Safety Analysis. (Rochester Gas and Electric Corp., N. Y.). [nd]. 189p. (DOCKET-50-244(Exh.D)(Vol.2)(Pt.A)). Dep. mn. CFSTI $5.00 cy, $1.00 mn.

A complete description of the reactor and its associated components is given. Part A contains a description of the site and environment, the reactor, reactor coolant system, and the containment system. Part B contains separate sections on engineering safeguards, plant instrumentation and control, electrical systems, auxiliary and emergency systems, steam and power conversion system, radioactive wastes and radiation protection, safety evaluation, and training program. (M.O.W.)

28757 (NP-15908(Exh.D)(Vol.2)(Pt.B)) BROOKWOOD NUCLEAR STATION UNIT NO. 1. PRELIMINARY FACILITY DESCRIPTION AND SAFETY ANALYSIS REPORT. Plant Design Description and Safety Analysis. (Rochester Gas and Electric Corp., N. Y.). [nd]. 158p. (DOCKET-50-244(Exh.D)(Vol.2)(Pt.B)). Dep. mn. CFSTI $5.00 cy, $1.00 mn.

28758 (NYO-3270-2(Vol.1)) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT I. FINAL ENGINEERING REPORT AND SAFETY ANALYSIS. VOLUME I. (Southern California Edison Co., Camp Pendleton, Calif. San Diego Gas and Electric Co., Calif.). [nd]. Contract AT(30-1)-3270. 377p. Dep. mn. CFSTI $7.00 cy, $1.75 mn.

A description of the reactor site is given in terms of meteorology, geology, hydrology, seismology, oceanography, and tsunami. The reactor cycle of the plant facilities is described in terms of mechanical design, thermal-hydraulic design, nuclear design, coolant system, chemi-

cal and volume control system, auxiliary coolant system, sampling system, fuel handling and transfer system, and the radioactive waste disposal system. (M.O.W.)

28759 (NYO–3270-2(Vol.2)) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT I. FINAL ENGINEERING REPORT AND SAFETY ANALYSIS. VOLUME II. (Southern California Edison Co., Camp Pendleton, Calif. San Diego Gas and Electric Co., Calif.). [nd]. Contract AT(30-1)-3270. 287p. Dep. mn. CFSTI $6.00 cy, $1.50 mn.

The turbine cycle of the plant facilities is described along with electrical systems, control room, and plant services. Safety systems are described. In particular, the safety injection system, shielding, and containment sphere are described. Instrumentation and control systems are described in terms of the nuclear instrumentation system, reactor control and protection system, rod drive control system, rod position indicating system, steam generator level control system, in-core instrumentation system, radiation monitoring system, and health physics and laboratory equipment. (M.O.W.)

28760 (NYO–3270-2(Vol.3)) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT I. FINAL ENGINEERING REPORT AND SAFETY ANALYSIS. VOLUME III. (Southern California Edison Co., Camp Pendleton, Calif. San Diego Gas and Electric Co., Calif.). [nd]. Contract AT(30-1)-3270. 278p. Dep. mn. CFSTI $6.00 cy, $1.00 mn.

Research and developments on the reactor are briefly discussed. Reactivity fault analyses were made in reference to startup, rod withdrawal at power, boron dilution, cold water, dropped rod, and control rod ejection accident. Mechanical malfunction analyses were made in terms of loss of coolant, loss of coolant flow, fuel handling, steam line break, steam generator tube rupture, loss of load, and waste gas accident. The plant behavior is discussed during loss of power, earthquakes, floods, landslides, and fire. Also chemical reactions and the fission product release from the fuel are described. The maximum hypothetical accident is described. (M.O.W.)

28761 (NYO–3280-1(Vol.1)(Bk.1)) PM-3A NUCLEAR POWER PLANT DESIGN ANALYSIS REPORT. Andonedis, A. (Burns and Roe, Inc., New York. Nuclear Engineering Dept.). Dec. 1965. Contract AT(30-1)-3280. 1021p. Dep. mn. CFSTI $13.21 cy, $4.25 mn.

Included is a compilation of technical design information including: (1) system description, design features, and operating limits; (2) component description, design features, and operating limits; (3) plant set points and allowable ranges of set points and important operating parameters; and (4) support documentation to substantiate analyses. (M.O.W.)

28762 (STI-DOC-10/49) USE OF PLUTONIUM FOR POWER PRODUCTION. Technical Reports Series No. 49. Report of a Panel, Held in Vienna, December 7–11, 1964. (International Atomic Energy Agency, Vienna (Austria)). 1965. 164p. IAEA: $3.50; S73,50; £ 1.1.0; F Fr 14,–; DM 12,25.

Separate abstracts were prepared for 10 of the 12 included sections. The remaining two appeared previously in NSA as: 19: 3587 and 19398. (M.O.W.)

For abstracts of individual papers see: 28797–28806.

28763 (TRG-Report–665) SONIC METHODS FOR P.F.R. CHANNEL BLOCKAGE DETECTION. Walton, A. J. (Reactor Group, United Kingdom Atomic Energy Authority, Risley (England)). Oct. 29, 1963. 22p. Dep. BIS $0.70. HMSO 3s. 6d.

Channel blockage in a P.F.R. sub-assembly may lead to loss of coolant flow and hence to boiling in the sodium. Acoustics offers the possibilities of two methods for the detection of the presence of bubbles arising from coolant boiling. Blockage detection by "listening" is feasible, provided that the noise produced by boiling can be distinguished from the background, by transducers placed at the most suitable points in the system. Experimental work shows that wide-band noise is produced when vapor bubbles from a heated surface collapse upon entry into a sub-cooled region. Gas bubbles, which are also produced by boiling in water containing air, or sodium containing argon, act as resonators at frequencies inversely proportional to their size. The resultant noise spectrum, due to boiling at a heated surface in a vessel containing water, covers the audio frequency range but the shape depends on the number and size of air bubbles present. It is further modified by the geometry of the vessel in which boiling takes place. Boiling in static sodium is likely to produce very similar noise. Flow will reduce the size of bubbles formed, so that resonances are at higher frequencies where the wide-band energy is less. (auth)

28764 (WAPD-MRP–116) PRESSURIZED WATER REACTOR (PWR) PROJECT. Technical Progress Report, January 22–April 22, 1966. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Contract AT(11-1)-Gen-14. 101p. Dep. mn. CFSTI $4.00 cy, $0.75 mn.

Research conducted during this period on the engineering and development of the Shippingport PWR is reported on the following: PWR plant support, reactor mechanical design, reactor thermal design, reactor physics, metallurgy of core materials, and core engineering. (M.O.W.)

28765 (WASH–1066) REACTOR PHYSICS EFFORTS REQUIRED IN SUPPORT OF THE FAST BREEDER DEVELOPMENT PROGRAM. (Division of Reactor Development and Technology (AEC), Washington, D. C. Reactor Physics Branch). Jan. 1966. 55p. Dep. mn. CFSTI $3.00 cy, $0.50 mn.

A summary is presented of physics efforts currently in progress, in the U. S. and abroad, which are pertinent to fast breeder reactor development. A discussion is presented of the technical problems that must be solved, both in the near-term and long-term development of fast breeder reactors. A recommended program of research in fast reactor physics is included. (M.O.W.)

28766 (WCAP–3385-51) SAXTON PLUTONIUM PROGRAM. NUCLEAR DESIGN OF THE SAXTON PARTIAL PLUTONIUM CORE. Orr, W. L.; Sternberg, H. I.; Deramaix, P.; Chastain, R. H.; Bindler, L.; Impink, A. J. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Dec. 1965. Contract AT(30-1)-3385. 347p. (EURAEC–1490). Dep. mn. CFSTI $7.00 cy, $1.75 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

The purpose of the Saxton Plutonium Program is to develop information concerning the use of plutonium enriched fuel in pressurized water reactors. The nuclear design requirements were to establish a fuel enrichment and core configuration that would provide a design life of 8,250 MWD and an average irradiation in the plutonium fuel of 10,000 MWD/tonne. It was necessary to meet these objectives within a linear power limitation of 16 kw/ft. The nuclear design work reported concerns three areas. Initially, parameter studies were carried out to determine the performance characteristics of the Saxton reactor containing a partial core of plutonium. Later, more specific nuclear design calculations were carried out to set the enrichment specification and determine the available performance for a core containing nine central plutonium fuel assemblies with twelve surrounding uranium assemblies. Finally, a series of critical experiments using the design fuel and a supporting program of analysis were used to confirm the specified nuclear design. The Saxton Core II nuclear design is expected to have a lifetime capability of 9,300 MWD and achieve an average burnup in the plutonium fuel of 13,600 MWD/tonne. The supporting critical experiment program provided significant beginning-of-life physics information about the fuel and the basis for improving the correlation of analysis with experiment for plutonium fueled systems. (auth)

28767 (WCAP–3385-53) SAXTON PLUTONIUM PROGRAM. MATERIALS DESIGN AND FABRICATION OF THE SAXTON PARTIAL PLUTONIUM CORE. Biancheria, A.; Stanutz, R. N.; Allio, R. J.; Houston, M. D.; Ray, W. E.; Rose, R. G. (Westinghouse Electric Corp., Pittsburgh, Pa.

Atomic Power Div.). Dec. 1965. Contract AT(30-1)-3385. 116p. (EURAEC–1492). Dep. mn. CFSTI $4.00 cy, $0.75 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

The materials design and fuel fabrication portions of the Saxton Pu Project are described. Information is included concerning selection of cladding and fuel rod fabrication techniques employed for the project, development of fuel specifications, and providing materials information on design parameters and safety criteria. The fabrication techniques selected were vibrational compaction and pelletization of mechanically-mixed powder. The procedures used during manufacturing of the fuel rods and results of inspection and quality control are summarized. The fuel rods are expected to operate at maximum linear rod powers of 16 Kw/ft and peak exposures greater than 25,000 Mwd/t (Pu + U). Fuel central temperatures as high as 2100°C are expected. (J.R.D.)

28768 (WCAP–3385-54) SAXTON PLUTONIUM PROGRAM. CRITICAL EXPERIMENTS FOR THE SAXTON PARTIAL PLUTONIUM CORE. Taylor, E. G. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Dec, 1965. Contract AT(30-1)-3385. 308p. (EURAEC–1493). Dep. mn. CFSTI $7.00 cy, $1.50 mn.

Work Performed Under United States–Euratom Joint Research and Development Program.

Separate abstracts were prepared for all 7 of the included sections. (M.O.W.)

For abstracts of individual sections see: 28769–28775.

28769 (WCAP–3385-54, App.A) SINGLE-REGION EXPERIMENTS. Sternberg, H. I. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). 105p.

The data and results of the single region UO_2 and PuO_2–UO_2 critical experiments performed under the Saxton Plutonium Program are given. These results include experiments made to determine critical configurations, bucklings, power distributions, flux shapes, reactivity worths of various perturbations and temperature coefficients. (auth)

28770 (WCAP–3385-54, App.B) MULTI-REGION EXPERIMENTS. Orr, W. L.; Deramaix, P.; Sternberg, H. I. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). 68p.

The data and results of the multi-region UO_2 and PuO_2–UO_2 critical experiments performed under the Saxton Plutonium Program are given. These results include experiments made to determine the relative power distribution, reactivity, relative flux shapes, and temperature coefficients in multi-region cores. (auth)

28771 (WCAP–3385-54, App.C) MEASUREMENTS OF GAMMA-TO-FISSION RATIOS BY GAMMA-RAY SPECTROMETRY TO RELATE URANIUM–PLUTONIUM MULTIZONE POWER DISTRIBUTIONS. Hamilton, G. N.; Corbett, J. A. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). 21p.

Measurements of gamma-to-fission ratios between 6.6% PuO_2/UO_2 and 5.7% UO_2 are described with application to normalized power distribution measurements in multizoned systems. Experimental techniques consisted of measurements of fission product gamma decay schemes for both fuel types and the measurement of lanthanum-140 concentrations by gamma ray spectrometry from which relative fission ratios were established. Results agree favorably with values obtained by other experimental techniques and conventional methods of analysis. (auth)

28772 (WCAP–3385-54, App.D) MEASUREMENTS RELATING POWER SHARING BETWEEN Pu AND U FUEL RODS. Nath, R. J.; Leamer, R. D. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). 17p.

A method is described for direct measurement of fuel rod fission power through the use of heating rates. These measurements, when used in conjunction with subsequent measurements of fission product gamma decay, provide useful data for the interpretation of power sharing in low power critical experiments. A direct relationship is provided to relate conventional measurements of gamma activity for fuels having different fissile elements to the power sharing of the fuels. The particular experiments performed related power sharing in a multizoned core having both plutonium and uranium fuels. Results from measurements at the Westinghouse Reactor Evaluation Center show that a time dependent correction is necessary because of differences in the fission product decay characteristics of the fuels. This correction reaches a maximum value of 30% approximately 4 hours after shutdown. (auth)

28773 (WCAP–3385-54, App.E) VOID EFFECTS. Hanlen, D. F. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). 22p.

A series of voiding effect experiments was performed. The core grid plates were fabricated with holes interstitial to the fuel rod positioning holes. Thin-wall aluminum void tubes were inserted in several configurations and their effects on core operating characteristics were measured. Tables are included which (1) present the data derived from the several critical assembly operations and include reference to appropriate core diagrams, and (2) indicate the physical dimensions of core inserts and perturbations including fuel, void tubes, and core plates. Schematic cross sections of core loadings for the experiments conducted are given. (M.O.W.)

28774 (WCAP–3385-54, App.F) NOISE ANALYSIS EXPERIMENTS. Rajagapol, V. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). 4p.

Noise measurements were made with a miniature fission detector in different fuel rod locations in a multiregion core containing both PuO_2–UO_2 and UO_2 fuels and in a single-region core containing PuO_2–UO_2. The instrumentation was similar to that for ion chamber measurements. Analysis of the data showed that the power spectrum in all cases followed the response of the measuring system to a white noise source. (M.O.W.)

28775 (WCAP–3385-54, App.G) PULSED NEUTRON EXPERIMENTS. Hamilton, G. N. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). 7p.

Pulsed neutron experiments were performed in a square array of 5.7% enriched UO_2 fuel rods having a W/U of 4.13 : 1. During the course of the UO_2 experiments, the reactor was maintained in a subcritical condition by moderator level adjustments such that shutdown reactivities ranged between $0.04 and $2.29. Due to high background count rates, no attempt was made to determine α at just critical. Instead, the value of α at just critical was obtained by plotting subcritical neutron decay constants as a function (inverse square) of moderator level and extrapolating to the measured just critical level. A table gives the results of the neutron decay constants and shows the comparisons of the two methods of shutdown determination. (M.O.W.)

28776 (ANL-Trans–293) PROTOTYPE STUDIES AND PHENIX. Translated for Argonne National Lab., Ill., from Bull. Inform. Sci. Tech., No. 95, 79-115(1965). 57p. Dep. mn. JCL $5.60 fs, $1.91 mf.

Research into fast neutron type reactors is directed towards the construction of power stations having capacities of about 1,000 megawatts. The reactor Phénix, whose power should be between 125 and 250 megawatts and the construction of which might start in 1969, will represent an intermediate stage between Rapsodie and the large industrial reactors. The development program for the fast neutron reactor system provides for a considerable effort in the essential domain of the reactor fuel and of its canning. Much other theoretical and experimental work is also underway however. This concerns in particular reactor physics, the structure of the reactor and its protection, the handling of the fuels, and the energy-recovering circuits. The development of the sodium-water heat-exchangers will be carried out at the Grand Quevilly thermal test station. Results from the above mentioned research are presented. (auth)

28777 TWENTY YEARS OF DEVELOPMENT. THE ATOMIC PROGRAM OF GREAT BRITAIN HAS KEPT ITS PROMISES. White, Stanley. Belgicatom, Ass. Belge Develop. Pac. Energ. At., Bull. Inform., 10: No. 59, 3-7 (Dec. 1965). (In French).

The history of development of atomic energy in Great Britain is briefly reviewed with the emphasis on the advantageous results obtained. (J.S.R.)

28778 NUCLEAR ENERGY IN GREAT BRITAIN AND ITS FUTURE. Stewart, J.-C.-C. Belgicatom, Ass. Belge Develop. Pac. Energ. At., Bull. Inform., 10: No. 59, 17-26 (Dec. 1965). (In French).

The fuel needs of Great Britain and its energy policies for the future are summarized. The factors leading to the construction of advanced gas cooled reactor at Dungeness are discussed. The British views on the fast neutron breeding reactors are described. (J.S.R.)

28779 DEVELOPMENT OF ATOMIC POWER. Petros'yants, A. M. At. Energ. (USSR), 20: 199-206 (Mar. 1966). (In Russian).

The status of the development of nuclear power in the Soviet Union is summarized. The role of the Russian Atomic Electric Commission in the various reactor programs is outlined, and various economic considerations are discussed. (G.O.Y.)

28780 DETERMINATION OF FEED WATER TEMPERATURE OF NUCLEAR POWER STATIONS WITH BOILING WATER REACTORS AND NUCLEAR SUPERHEATING. Danila, N.; Haiduc, C. Bul. Inst. Politeh. Gheorghe Gheorghiu-Dej Bucuresti, 27: 129-44(Sept.-Oct. 1965). (In Rumanian).

The method of determining the optimum temperature of feed water in the case of nuclear power stations with boiling water reactors and nuclear superheating is established. (auth)

28781 EXPORTING AGR POWER PLANT. Dent, K. H. (United Kingdom Atomic Energy Authority, Windscale, Eng.). Elec. Rev., 177: 306-10(Aug. 27, 1965).

A series of AGR power plants that were designed for export are discussed including both design features and economic aspects. (D.C.W.)

28782 NUCLEAR PLANT EVALUATION MORE COMPLEX IN PHASE II. Houser, H. G.; Nordman, D. A. (Westinghouse Electric Corp., East Pittsburgh). Elec. World, 165: 29-31(May 23, 1966).

The economic evaluation of the replacement of nuclear power units by advanced nuclear power units and of the incorporation of advanced power units in existing power systems is discussed. (D.C.W.)

28783 COMPACT AK PROCESS NUCLEAR SYSTEM. Crim, W. M. Jr.; Hoffmann, J. R.; Manning, G. B. (U. S. Army Engineers Reactors Group, Fort Belvoir, Va.). J. Eng. Power., 88A: 127-38(Apr. 1966).

The concept, theories to be explored, initial design, detailed design, fabrication and construction, and initial testing in the first experimental, compact, closed-cycle (AK process) thermodynamic system are described. The thermodynamic basis of the closed-cycle-turbine power plant is the Ackeret-Keller or AK process which shows how maximum work can be attained between given temperature limits. Both the Carnot and AK cycles require isothermal compression and expansion over a moderate pressure ratio, the major difference between them being that the Carnot cycle requires the use of additional machinery and the AK cycle needs heat transfer apparatus to achieve the temperature range. Other advantages of the cycle are the low pressures and exotic gases that can be used, such as He and N_2. The results of the experimental work to date have shown that the compact, closed-gas cycle, employing the basic aerothermodynamic principles as discussed, can provide a feasible compact reactor system. (auth)

28784 EVALUATION OF OPTIMUM POWER EFFICIENCY FOR D_2O–CO_2 TYPE NUCLEAR POWER PLANTS. Svec, P. V. (Inst. of Nuclear Physics Technology, Prague). Jad. Energ., 12: 41-6(1966). (In Czech).

An analytical method of the determination of the optimum electric power (or the optimum electric power of gas circulators) of a nuclear power station with gas-cooled (or with other nonboiling medium cooled) reactors is described. A comparison is given of optimum parameters according to the following criteria: maximum electric power $N_{e_{max}}$, minimum investment costs C_{min}, the minimum costs of electricity generation S_{min} and the minimum calculated costs of electricity generation (with profit) Z_{min}. (auth)

28785 RADIOMETRIC DETERMINATION OF CO_2 LEAKAGE IN STEAM GENERATORS OF A NUCLEAR POWER PLANT. Kabat, Miloslav (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Prague). Jad. Energ., 12: 93-8(1966). (In Czech).

A review of dosimetric problems in nuclear power plants given in the literature indicated that the dosimetric system of technological inspection in gas cooled reactor stations needs to develop particular dosimetric methods and instruments complying with the extraordinary operational conditions occurring principally in technological cycles. The solution of one fundamental problem—the measurement of cooling gas leakage from the primary cycle into the secondary cycle steam in a steam generator—is described. (tr-auth)

28786 HIGH-TEMPERATURE CO_2 LOOP FOR EXPERIMENTAL FUEL IRRADIATIONS IN THE BR 2 REACTOR, MOL. Knaab, H.; Stehle, H. (Siemens-Schuckerwerke AG, Erlangen, Ger.). Kerntechnik, 8: 158-63(Apr. 1966). (In German).

A detailed description is given of the high temperature CO_2 loop installed in the BR 2 reactor. The circuits and installation in the reactor, components of the primary circuit, auxiliary circuits, and the instrumentation and electric devices are considered. (J.S.R.)

28787 IRRADIATION EXPERIMENTS FOR THE DRAGON HIGH-TEMPERATURE GAS-COOLED REACTOR. Saunders, R. A. (OECD, Winfrith, Eng.). Kerntechnik, 8: 166-71(Apr. 1966).

A brief description is given of the irradiation experiments performed on steel, graphite, fuel capsule, fuel element replacement rig, high power density rig, fission product loops, Pluto loop, and in-pile carbon transport loop. The significant design features and problem areas are indicated. (J.S.R.)

28788 DEVELOPMENT PROBLEMS OF THE AKB REACTORS. Keller, W. (Siemens-Schuckertwerke, Erlangen, Ger.). Neue Tech., 7: 263-71(Dec. 1965). (In German).

The AKB reactor is a heavy water moderated, CO_2-cooled pressure tube reactor designed for an output of 100 Mwe. The development problems encountered with respect to the fuel elements, coolant channels, moderator circuit, CO_2 circuit, and the reactor physics are outlined. The solutions determined are outlined. (J.S.R.)

28789 DESIGN PROBLEMS WITH HEAVY-WATER-MODERATED PRESSURE-TUBE REACTORS. Lys, L. A.; Crimmins, D. H. (Swiss Federal Inst. for Reactor Research (EIR), Wuerenlingen, Switzerland). Neue Tech., 8: 1-10(Feb. 1966).

The results of a study of a 250-Mw(e) power plant using a steam-cooled heavy-water-moderated reactor are presented. The water is evaporated in an external heat exchanger; and the reactor acts as a superheater, delivering steam both to the evaporators and to the turbines. The entire design was optimized for the minimum energy cost. (D.C.W.)

28790 INTERIM REPORT ON THE UoG PROJECT. Naegelin, R. (Therm-Atom AG, Winterthur, Switzerland). Neue Tech., 8: 10-21(Feb. 1966). (In German).

The project work under way at Therm-Atom on a heavy-water-moderated, gas-cooled, and oxide-fuelled power reactor of 250 Mw(e) is summarized. After a short de-

scription of a computer program for the dimensioning of such plants, different possibilities for the thermal insulation of the pressure tubes, the gas flow in the reactor core, and the construction of the fuel elements are discussed. Some partial results allowing a comparison of four different fuel cycles are given. Arguments for a horizontal or vertical disposition of the reactor axis are also included. (auth)

28791 STATE OF WORK FOR THE UmG PROJECT. Helbling, W. (Therm-Atom AG, Winterthur, Switzerland). Neue Tech., 8: 21-31(Feb. 1966). (In German).

The results of design studies for a 250-Mwe Co_2-cooled heavy-water-moderated reactor using metallic fuel are presented. (D.C.W.)

28792 EARTHQUAKE RESEARCH PROBLEMS OF NUCLEAR POWER PLANTS. Housner, G. W.; Hudson, D. E. (California Inst. of Tech., Pasadena). Nucl. Eng. Design, 3: 308-19(1966).

Earthquake problems associated with the construction of nuclear power plants require a more extensive and a more precise knowledge of earthquake characteristics and the dynamic behavior of structures than was considered necessary for ordinary buildings. Economic considerations indicate the desirability of additional research on the problems of earthquakes and nuclear reactors. The nature of these earthquake-resistant design problems is discussed and programs of research are recommended. (auth)

28793 RADIATION AND CREEP ANALYSIS FOR TUBULAR FUEL ELEMENTS AT UNSTEADY STATE. Ma, B. M. (Iowa State Univ., Ames). Nucl. Eng. Design, 3: 402-11(Apr. 1966).

A radiation and creep analysis for strain rates, strains and stresses induced by thermal cycling, radiation and creep in long, tubular fuel elements at unsteady state is presented. The primary effects of thermal-cycling growth, irradiation growth, swelling and creep of the fuel materials for nuclear power reactors are considered. The thermal, radiation, and time effects on the components of strain rate, strain and stress produced in the fuel elements are shown from equations and the calculated results of a numerical example. (auth)

28794 THERMAL SHIELD VIBRATION ELIMINATED AT BIG ROCK POINT. Nucleonics, 24: No. 5, 64-5(May 1966).

The design and testing of a new thermal shield for the Big Rock Point reactor are described. (L.B.S.)

28795 PREDICTING PERFORMANCE OF D_2O STEAM TURBINES IN BOILING HEAVY-WATER REACTORS. Christensen, Joergen (Aktiebolaget Atomenergi, Stockholm); Olesen, Carsten B. Nucleonics, 24: No. 5, 66-8 (May 1966).

Estimates for the 200-Mw(e) Marviken D_2O steam turbine show an expected leakage of 1,100 lb of D_2O and an estimated entry of 1,500 lb of H_2O per year. These values contribute <0.1 mills/kwh to station cost. (L.B.S.)

28796 IRRADIATION TESTING OF CERAMIC NUCLEAR FUELS. Mirion, I. (Inst. of Atomic Physics, Bucharest). Studii Cercet. Fiz., 17: 1133-8(1965). (In Rumanian).

The goal of the irradiation testing of nuclear fuels is to establish the maximum burnup level under actual operating conditions. For ceramic fuels the following properties are of special importance: susceptibility to cracking, release of gaseous fission products, expansion or swelling caused by the formation of gases; changes in physical properties and in the chemical composition, especially in the thermal conductivity. Uranium oxide, UO_2, as the most widely used ceramic material was used as an example in the review. Its low thermal conductivity results in the establishment of high temperature gradients, inducing stresses which may cause cracking and even complete fracturing of the material. This situation may be tolerated in the case of clad fuels. The problem of fission product release is of lesser importance for water-cooled fuels because the working temperature is relatively low but it must be taken into account for gas-cooled fuel elements with high surface temperatures. The amount of the gas released is a function of temperature; it reaches 100% at about 1800°C. Retention of the fission gases may result in strong swelling; such structural changes represent the chief limiting factor of the burnup level. At low temperatures, the thermal conductivity decreases with irradiation. Recent experiments indicated that it might be possible to operate UO_2 elements with a molten center portion. (TTT)

28797 BELGIUM'S PROGRAM ON THE USE OF PLUTONIUM IN NUCLEAR REACTORS. Vanden Bemden, E. (Centre d'Etude de l'Energie Nucleaire, Brussels). pp 1-10 of STI-DOC-10/49. (In French).

The program in Belgium has two objectives. One is the use of plutonium in existing water reactors and in power plants of the same type especially adapted to this mode of enrichment. The second objective is the use of plutonium in fast reactors. The second objective is a long term project requiring less effort than the first project. The studies made on the use of plutonium in existing water reactors are summarized in some detail. (J.S.R.)

28798 UTILIZATION OF PLUTONIUM IN POWER REACTORS. Vendryes, G.; Clauzon, P.; Gaussens, J.; Joly, R.; Sebilleau, F.; Tretiakoff, O. (Commissariat a l'Energie Atomique, France). pp 19-28 of STI-DOC-10/49. (In French).

The utilization of plutonium in power reactors is analyzed with respect to the fundamental nuclear data concerning plutonium utilization in thermal reactors, utilization in fast reactors, reprocessing and refabrication of plutonium fuels, and economic considerations. (J.S.R.)

28799 A STUDY OF PLUTONIUM RECYCLE WITH THORIUM IN FAST AND THERMAL REACTORS. Paranjpe, S. R. (Atomic Energy Establishment, Trombay, Bombay). pp 29-38 of STI-DOC-10/49.

An investigation was made on Pu–Th recycling in light or heavy water-moderated thermal reactors for estimating the inventory requirements of these reactors, attainable conversion ratios, and the influence of various factors like the uncertainties in cross sections. Various calculations point out the performance of PuO_2-ThO_2, PuO_2-Th, and UO_2-PuO_2 paste fuels for use in fast sodium-cooled reactors. The results are discussed. (M.O.W.)

28800 OUTLOOK ON THE UTILIZATION OF PLUTONIUM IN POWER REACTORS IN ITALY. Sani, L. (Ente Nazionale per l'Energia Elettrica, Rome). pp 39-44 of STI-DOC-10/49.

Tables give the plutonium content in irradiated fuel from the Italian Nuclear Power Stations: Latina, Garigliano, and Trino Vercellese. Economic considerations for Pu recovery from the fuels are briefly discussed. The Italian program for Pu utilization in thermal reactors is briefly described. (M.O.W.)

28801 THE PRESENT STATUS OF THE APPLICATION OF PLUTONIUM IN JAPAN. Oomachi, S. (Atomic Energy Bureau, Tokyo). pp 45-9 of STI-DOC-10/49.

The present status of Pu research and development and the program of reprocessing-plant construction in Japan are briefly described. A fast-breeder development plan is described. (M.O.W.)

28802 THE PROSPECTS OF PLUTONIUM FOR POWER GENERATION IN JAPAN. Takahashi, M. (Central Research Institute of Electric Power Industry, Tokyo). pp 50-5 of STI-DOC-10/49.

Plutonium production in Japan from 1968 to 1976 is discussed. The prospects for using Pu for fast and thermal reactors are discussed along with some economic problems. (M.O.W.)

28803 US PROGRAMME: TECHNOLOGY FOR PLUTONIUM FUELS IN THERMAL REACTORS. Albaugh, F. W. (Hanford Labs., Richland, Wash.). pp 71-92 of STI-DOC-10/49.

Plutonium fuels development (PuO_2-UO_2) is discussed in terms of fabrication processes, fabrication costs, fuel

element designs, fuel irradiation, and reactor decontamination. Some Pu-recycle reactor physics calculations are presented. Chemical reprocessing of the PuO_2-UO_2 fuels is briefly discussed. (M.O.W.)

28804 US PROGRAMME: PLUTONIUM FOR FAST REACTORS. Lawroski, S. (Argonne National Lab., Ill.). pp 93-119 of STI-DOC-10/49.

Plutonium fuels development (U–Pu, UC–PuC, and UO_2-PuO_2) for fast reactors is described in terms of fabrication, fuel claddings for, burnup, and processing. Sodium technology and corrosion are described. Various other aspects of system components and equipment for fast reactors employing Pu fuels are discussed. (M.O.W.)

28805 STUDIES PERFORMED IN THE COMMUNITY ON THE UTILIZATION OF PLUTONIUM IN NUCLEAR REACTORS. Raievski, V. (EURATOM, Centre Commun de Recherche d'Ispra, Italy). pp 120-34 of STI-DOC-10/49. (In French).

The activities of EURATOM in the studies on the utilization of plutonium in nuclear reactors are described. The physical effects of plutonium in thermal reactors with respect to the high thermal cross section, the neighboring resonance of the thermal region, the epithermal adsorption, calculation of evolution and experimental problems are examined briefly. The results of CEA studies on physical properties of UO_2-PuO_2 mixtures and on the fabrication of dispersed elements are summarized. The physics of plutonium in graphite-gas reactors of the EDF type and heavy water reactors of the EL-4 type are discussed. The physics of plutonium lattices and of plutonium fuel cycles are summarized. The neutron, metallurgical, safety, and plutonium cycle problems encountered in the utilization of plutonium are summarized. The recommendations of the AIEA for cooperative studies on the utilization of plutonium are tabulated. (J.S.R.)

28806 ECONOMIC ASPECTS OF UTILIZATION OF PLUTONIUM IN POWER REACTORS. Mechaelis, H.; Scalliet, R.; Willens, M. (EURATOM, Brussel). pp 135-46 of STI-DOC-10/49. (In French).

The economic aspects of the plutonium utilization in power reactors are discussed with respect to the production cost for plutonium and utilization values for plutonium. It was concluded that since it seems technically possible to recycle plutonium in fast reactors and in thermal reactors, the utilization of these techniques will be essentially limited by economic considerations. The utilization values of plutonium both in thermal and in fast reactors support favorably the comparison with the production cost of the plutonium produced in thermal reactors. During the period of transition during which the fast breeders will be introduced progressively into the programs for nuclear electricity production, a large quantity of plutonium would be recycled in thermal reactors. (J.S.R.)

28807 NUCLEAR REACTOR. Lindberg, John Emery Jr. British Patent 1,025,552. Apr. 14, 1966. Filed Feb. 11, 1963.

A nuclear reactor power system includes a pair of nuclear reactors containing a supply of heat transfer medium consisting of a metal hydride which is dissociable endothermically in one reactor into the metal and hydrogen and which is reformable by exothermic recombination of the metal and hydrogen in the other reactor. A conduit connects the reactors that are arranged to operate alternatively with one reactor initially containing the hydride and the other containing the metal. A heat exchanger is associated with each reactor so that the heat generated in the inactive reactor by the exothermic formation of the hydride is transferred through the associated heat exchanger to a point of utilization. A compressor or a turbine is associated with each reactor as a power device. The alternate operation of the reactors is controlled by automatic control means. Suitable hydrides which also serve as the moderator for the reactors are LiH or ZrH_4. The power system is particularly applicable to the propulsion of aircraft. (B.L.M.)

28808 SAFETY ARRANGEMENT FOR THE CONTAINMENT OF POWER REACTORS. Ziegler, Albert; Petersen, Gerd; Weishaupt, Erwin (to Siemens-Schuckertwerke AG). German Patent 1,207,024. Dec. 16, 1965. Filed June 14, 1961.

To achieve the vapor-suppression containment of nuclear power reactors the shell enclosing said reactors is connected to an expansible gas holder (wet gasometer) so as to permit vapor, which could develop in the event of leakage from the reactor, to flow with little resistance from the shell into said gas holder. A spray system fed from an overhead tank at the ceiling of the gas-holder bell can condense the vapor and reduce the pressure considerably. (Gmelin Inst.)

28809 METHOD FOR THE CONTROL OF A NUCLEAR REACTOR INSTALLATION. Drorszlai, Pal (to Gebrueder Sulzer AG). German Patent 1,207,025. Dec. 16, 1965. Priority date May 17, 1963.

A constant-outlet-temperature program for the coolant flow in the primary circuit is given which comprises the continuous variation of the flow of the working medium in the secondary circuit in dependence upon the outlet temperature of the primary coolant flow and additionally upon the neutron flux of the core. (Gmelin Inst.)

28810 SPHERICAL FUEL ELEMENT FOR HIGH-TEMPERATURE POWER REACTORS AND DEVICE FOR PRODUCING THE SAME. Rachor, Lothar (NUKEM Nuklear-Chemie und -Metallurgie GmbH). German Patent 1,208,014. Dec. 30, 1965. Filed Sept. 13, 1963.

The spherical fuel element according to patent 1,202,910 comprising a spherical cavity the inside of which is coated with a layer of fuel, a filler opening closed by a plug, and a filling material such as graphite, is improved in that the cross section of the filler opening is substantially smaller than the cross section of the spherical cavity. The ratio of the cross section of the filler opening to the cross section of the cavity amounts to 0.5:1 to 0.2:1. (Gmelin Inst.)

28811 NUCLEAR REACTOR POWER CONVERSION SYSTEM. Rose, David; Hanitzsch, Konstantin Johann (to General Dynamics Corp.). U. S. Patent 3,244,598. Apr. 5, 1966. Filed Jan. 2, 1963.

A system is described for effecting the conversion of the heat extracted from an operating nuclear reactor by a heat extracting medium circulating in the primary coolant loop of the reactor into usable electrical energy. The extracted heat is supplied to a steam generator connected to the reactor by the heat extracting medium circulating through the steam generator. The system employs a steam turbine driven circulator in that portion of the steam cycle that ensures efficient circulator operation, minimizes the possibility of damaging effects to the steam turbine, reduces the power drain on the power output of the main steam cycle, and simplifies integration within the overall steam system design. This steam turbine driven circulator more efficiently yields the necessary circulation rate for the coolant at increased reactor power output and yields more efficient variable speed performance for varying reactor operating conditions than do electric motor driven circulators. (B.L.M.)

Process Heat Reactors

28812 (ORNL–3962) ABSTRACTS OF PAPERS, WATER DESALINATION INFORMATION MEETING, MAY 10-11, 1966. Kraus, K. A.; Hammond, R. P. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. 66p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Abstracts of 15 papers presented on the water research and nuclear desalination programs are presented. (M.O.W.)

28813 NUCLEAR POWER AND DESALINATION. Koryakin, Yu. I.; Loginov, A. A. At. Energ. (USSR), 20: 232-43(Mar. 1966). (In Russian).

The use of nuclear power in the desalination of sea water is discussed. Economic questions, possible engineering

problems, distillation technology, and the efficiency of distillation installations are considered. (D.C.W.)

28814 QUESTIONS AND PROBLEMS OF THE UTILIZATION OF NUCLEAR SOURCES IN THE AREA OF DISTRICT HEATING. Dlouhy, Frantisek; Bortlik, Iiri (Energoprojekt, Prague). Jad. Energ., 12: 88-92(1966). (In Czech).

The general questions connected with the utilization of nuclear reactors in district heating are shown. Separate sections of the work were devoted to the problems of positioning the nuclear district heating installations, delivery of heat to the consumer, and economic questions. The advantages and disadvantages of district heating by nuclear installations in comparison with heating installations using conventional fuels were reported. The design of the basic thermal circuit of nuclear district heating power plants was given. A list of the present nuclear sources for district heating is reported. (tr-auth)

28815 NUCLEAR ENERGY: POTENTIAL FOR DESALTING. Ramey, James T.; Swartout, J. A.; Williams, W. A. (Atomic Energy Commission, Washington, D. C.). Mech. Eng., 88: No. 4, 52-5(Apr. 1966).

The development of nuclear power for desalination is discussed. The history of this development, the advantages of nuclear energy, the AEC program for desalting application, and the problem of technology scale-up are considered. Trends in costs of nuclear power plants, data from dual-purpose plant studies, fuel costs for light water reactors, and the effects of the size of the nuclear fuel industry on fuel costs are given. (J.F.P.)

Production Reactors

Refer also to abstract 26744.

28816 (RL-SA-44) INSPECTION OF CRITICAL PROCESS TUBE COMPONENTS AT HANFORD. Bennett, Earl C. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). June 25, 1965. Contract AT(45-1)-1350. 15p. (CONF-650710-5). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From American Nuclear Society, Meeting on Reactor Operating Experience, Jackson Lake Lodge, Wyo.

The maintenance program for replacing the aluminum process tubes and their components at Hanford is described. (M.O.W.)

Propulsion and Space

See also ENGINEERING — Space Propulsion

Refer also to abstract 27072.

28817 (EUR-1621.e(Vol.3)) TECHNICAL SAFETY EVALUATION OF THE N. S. "SAVANNAH". Fourth Supplement. (Bureau Veritas, S. A., Paris (France). Germanischer Lloyd, Hamburg (West Germany)). Apr. 1966. 46p. Dep. mn.

The following safety evaluation work for the N. S. Savannah was summarized and analyzed: (1) further maintenance, repair and replacement work performed during the first and the second outages and inspection periods at Galveston and the resultant structural changes on a number of items, (2) the reported indications on some of the operational experience, (3) the incidence of certain structural changes on the assumptions chosen for the assessment of potential accident situations, and (4) the status of the port operating criteria presently applied and the repair and maintenance work requirements. (M.O.W.)

28818 (GA-6890) TUNGSTEN NUCLEAR ROCKET. PHASE I, FINAL REPORT. PART I. Bardes, R. G.; Cohen, S. C.; Friesenhahn, S. J.; Gillette, E. M.; Haddad, E.; Joanou, G. D.; Jupiter, C.; Moore, R. A.; Peak, J. C.; Trimble, G. D. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Apr. 22, 1966. Contract SNPC-27. 390p. (NASA-CR-54909).

The critical experiments and nuclear analysis performed at General Atomic in support of the Tungsten Water-Moderated Nuclear Rocket Reactor being developed by NASA-Lewis Research Center are described. Descriptions of the critical facility and the critical assemblies are given. Experimental measurements are presented and compared with analytical results. Analytical methods are reviewed and some critical experiments previously performed at the NASA-Lewis Research Center are analyzed. Three different core configurations of 121 fuel elements were assembled; two different pitches and both water and beryllium reflectors were used. Excess reactivity was held down by a cadmium nitrate solution contained in 204 poison tubes throughout the core. The fuel element consisted of an assembly of enriched uranium-aluminum alloy, depleted uranium, tungsten foil, and structural aluminum. Experimental results include the excess reactivity available in the cores, the worth of poison tubes and fuel element components at various locations, the temperature coefficient of the cores, flux and power distributions in a cell and throughout the core, neutron and gamma ray dose rate distributions throughout the core, pulsed neutron measurements, and reactivity comparisons using a special fuel section of enriched tungsten. Nuclear analysis of the assemblies required careful treatment of the extreme heterogeneities of the core. A detailed analysis which accounts for the two-dimensional cell structure, resonance overlap, and two-region resonance effects gave good agreement between calculations and the experimental results. (auth)

28819 (LA-3448) GAMMA DOSE RATE MEASUREMENTS ON THE PHOEBUS 1A-321 REACTOR. Ahlquist, A. J.; Sanders, F. W. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Dec. 1965. Contract W-7405-eng-36. 19p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

Gamma-ray dose rate measurements were made on Experimental Plans 2, 3, and 4 of the Phoebus 1A-321 reactor testing series. Extrapolation of data from 180 feet gave a dose rate of 36.0 R/min-MW at the 60 foot station during the full power run (Experimental Plan 4). The average gamma-ray dose rate of the eight Kiwi reactors at the 60 foot station was 35.1 R/min-MW. Instrument difficulties necessitated using xylene (gamma-neutron sensitive) detectors as gamma detectors. Integral doses show that they give a reasonable approximation of gamma dose rates. (auth)

28820 (LA-DC-7244) NUCLEAR REACTOR CONTROL WITH STEPPING MOTOR ACTUATORS. Strait, Bobby G.; Lang, Robert M. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [1966]. Contract W-7405-eng-36. 29p. (CONF-660608-7). Dep. mn. CFSTI $2.00 cy, $0.50 mn.

From 2nd AIAA Propulsion Joint Specialist Conference, Colorado Springs.

A control rod actuator system capable of reproducing the position of rotary control rods to 0.01° was developed for the Phoebus-2 Zepo critical assembly (a zero power neutronic mockup for the Rover reactor, Phoebus-2). The heart of the actuator is an electric stepping motor whose output shaft rotates 1.8° for each input electrical pulse. Each step is accurate to ±5%, and the rotational error is non-cumulative. Steps of 0.01° are obtained by means of a 180:1 gear reduction, combined with a spring load on the output shaft to eliminate backlash. Control rod position information is obtained by simply counting algebraically the number of electrical pulses which step the motor. The safety philosophy is based on limiting the pulse rate, which limits the rate of increase of reactivity. In addition, a fail-safe scram system is provided in the form of an electrically-operated clutch, which decouples a control rod from its gear train and allows a spring to scram the rod. The system also includes a power level control loop which uses either one or two control rods as the control elements. The electronic controls for the stepping motors consist of highly reliable transistor circuits which operate in switching fashion; that is, the transistors are completely on or off. (auth)

28821 (LA-DC-7641) ON THE EFFECTS OF COOLDOWN REQUIREMENTS UPON MISSION APPLICATIONS FOR NUCLEAR ROCKETS. Fenstermacher, Charles (Los Alamos Scientific Lab., Univ. of California, N. Mex.); Oakley, Donald T. (Public Health Service, Las Vegas, Nev.). [1965]. Contract W-7405-eng-36. 14p. (CONF-660608-4). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From 2nd AIAA Propulsion Joint Specialist Conference, Colorado Springs.

When considering mission applications for nuclear rockets, one encounters the problem of the delayed energy produced by fission product decay after the full power operation phase. If restarts are not planned for the engine, the problem can be ignored because each engine is jettisoned at the end of its operation. However, if restarts are considered, at least two aspects of the cooldown problem must be examined. First, the program necessary for safe reactor cooldown and propellant requirements for this and second, the feasibility of producing useful thrust during this cooldown. Studies were made of the cooldown requirements as a function of operating times for mission applications at the NERVA-2 power level and their effects on the specific impulse and vehicle weight. These calculations include realistic limits upon exit gas temperatures imposed by reactor design considerations. The effects upon I_{sp} were studied using as a parameter the fraction of cooldown propellant assumed to produce thrust. The results indicate I_{sp} degradation of 2 to 15 seconds and vehicle weight increases of 6,000 to 40,000 lbs over the range considered. (auth)

28822 (LA-DC-7649) DESIGN AND ANALYSIS OF AN EMERGENCY COOLDOWN SYSTEM FOR NUCLEAR ROCKET REACTOR GROUND TESTS. Nutter, Murlin J.; Breisch, George; Fenstermacher, Charles (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [nd]. Contract W-7405-eng-36. 22p. (CONF-660608-6). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From 2nd AIAA Propulsion Joint Specialist Conference, Colorado Springs.

A system is described which will automatically provide coolant to a nuclear rocket test reactor during the initial portion of an emergency shutdown. The adiabatic expansion of the pressurizing gas in a variable volume automatically programs the flow of LH_2 from a high pressure dewar, through suitable valving, to cool the reactor safety when a system malfunction, facility failure, spurious signal or unpredicted reactor operation causes an emergency shutdown. Calculations involving the solution to the system differential equations, indicate that an acceptable shutdown can be produced for emergency shutdown situations over the range of expected Phoebus I and II operating conditions. (auth)

28823 (ORNL-P-1381) STATE-OF-THE-ART FOR NUCLEAR ELECTRIC SPACE POWER PLANTS. Fraas, A. P. (Oak Ridge National Lab., Tenn.). [1964]. Contract W-7405-eng-26. 7p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

The MPRE, a 1-Mw(t) single-fluid, potassium-vapor Rankine cycle system, is described. Economics and the operating performance of the MPRE for space power uses are discussed in general. (M.O.W.)

28824 DEVELOPMENT OF NAVAL FORCES. Dem'yanov, V. P. pp 293-338 of Atom i Oruzhie. Moscow, Publishing House of the USSR Ministry of Defence, 1964. (In Russian).

Nuclear power plants are very useful for the propulsion of naval ships because of the extreme compactness of the fuel requirements, as compared with oil; this is of special interest for submarines. The weight of the required biological shield is relatively large in the case of low-power reactors; therefore, large reactors are designed for ship propulsion. The overall cost of a nuclear system is still quite high. The principle of reactors is briefly reviewed, mentioning particularly water-moderated, water-cooled, boiling and gas-cooled systems and describing also the United States and United Kingdom nuclear naval programs. The changes in naval strategy caused by the introduction of nuclear propulsion systems are examined, pointing out the importance of the Polaris system. The submarine must know the intention and the location of its opponent, therefore it must rely on electronic detection and communication systems for protection instead of armor. Current studies on advanced propulsion methods, such as magnetohydrodynamic generators, direct transformation of thermal or chemical energy into electric energy are discussed. (TTT)

Research and Test Reactors

Refer also to abstracts 26778, 27035, 27349, 27572, and 28754.

28825 (AD-627807) THE RADIATION ENVIRONMENT IN THE EXPERIMENTAL FACILITIES OF THE DIAMOND ORDNANCE RADIATION FACILITY. Berman, Philip G. (Harry Diamond Labs., Washington, D. C.). Dec. 1, 1965. 154p. (TR-1307). CFSTI $5.00 cy, $1.00 mn.

Neutron fluence, fluence per kilowatt-hour, gamma exposure, and gamma exposure rate were measured. The data are presented in graphical form. The maximum attainable radiation exposure measured in the pulse mode is as follows: in the exposure room the neutron fluence ($E > 10$ kev) is 6.8×10^{13} n/sq cm and the gamma exposure is 500,000 R; in the pool the neutron fluence is 5.2×10^{13} and the gamma exposure 300,000 R. The maximum attainable radiation exposure rate, measured at a reactor power of 250 kw, is as follows: in the exposure room the neutron fluence ($E > 10$ kev) is 5.4×10^{12} n/sq cm sec and the gamma exposure is 2,100 R/sec; in the pool the neutron flux is 8.0×10^{11} n/sq cm sec and the gamma exposure is 1,300 R/sec. (STAR)

28826 (ANL-7100, pp 413-25) IMPURITY AND LIQUID LEVEL MEASUREMENTS FOR THE FARET LOOP. Hosler, A. G.; Smith, F. A. (Argonne National Lab., Ill.).

The circuit design and operation for a self-seeking level probe is given. Results of recent measurements of the sodium impurity levels are discussed. (W.L.G.)

28827 (BNWL-198, pp 5.1-4) JOINT FUEL DEVELOPMENT PROGRAMS. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Six EBWR pressure capsules were fabricated from standard EBWR tubing. During autoclaving at 290°C and 4500 psi, one empty capsule and one spring-loaded capsule collapsed. Thirteen of forty-four EBWR fuel rods (UO_2–1.5 wt % PuO_2) under irradiation were discharged. Of the remainder, 20 have a maximum burnup of 0.7×10^{20} fissions/cm^3. Twenty-nine discharged and three in-reactor capsules have achieved a maximum burnup of 5.2×10^{20} fissions/cm^3. Fuel element design was begun for the High Temperature Lattice Test Reactor (HTLTR). (auth)

28828 (BNWL-204) AQUEOUS DECLADDING AND DISSOLUTION OF PLUTONIUM RECYCLE TEST REACTOR FUELS. PART 1. PLUTONIUM-ALUMINUM ALLOY FUELS. Schulz, W. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1966. Contract AT(45-1)-1830. 20p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Certain factors such as activation behavior, instantaneous dissolution rates, and off-gas composition were determined during dissolution of various PRTR Pu–Al alloys in HNO_3–$Hg(NO_3)_2$ solutions. Pu–Al alloys irradiated to 28 to 45% burnup of their initial ^{239}Pu content, as well as unirradiated Pu–Al alloys, were studied (in 0.002 to 0.02M $Hg(NO_3)_2$ solution) at HNO_3 concentrations as high as 4M. Irradiated material activated only in dilute (~1M) HNO_3 solutions. A key property of irradiated PRTR Pu–Al alloys was that, after activation in dilute HNO_3 was achieved, concentrated HNO_3 could be added to the dissolvent to adjust its acidity to 4 to 6M without passivating the alloy. (Dissolution to 4 to 6M HNO_3 is desirable to reduce the amount of hydrogen in the off-gas and to achieve fast dissolution rates.) Advantag

of this property was taken in defining an activation-dissolution procedure for use in the Hanford Redox plant. (auth)

28829 (BNWL–207, pp 6.13-16) GAS LOOP DEVELOPMENT. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The model gas loop is a 2000°F, 500 lb/hr flow, He recirculating loop that is approximately a one-tenth model of the ATR He loop designed for installation in the Advanced Test Reactor (ATR) at Idaho Falls. Laboratory tests on a mockup of the seal between the pressure tube of the ATR gas loop and the columbium sleeve liner indicate the maximum clearance between the liner and the sleeve should not exceed 0.020 in. Disassembly of the model loop was started in preparation of the installation of the new model heater and foil insulated primary piping. Final assembly of the model heater is in progress. Piping for the loop is being prefabricated into three subassemblies before installation in the loop. (auth)

28830 (GEAP–4994) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR DEVELOPMENT PROGRAM. Quarterly Report No. 6, August–October 1965. Horst, K. M. (comp.) (General Electric Co., San Jose, Calif. Advanced Products Operation). Nov. 1965. Contract AT(04-3)-540. 129p. Dep. mn. CFSTI $4.00 cy, $1.00 mn.

An estimate was made of the number and types of oscillator tests which may be conducted during the Experimental Program. Calculations of net reactivity from the FORE code output of transient power versus time (using the KWIN code) have shown good agreement with the original FORE net reactivity variation. Work continued on using a two-group, time-dependent, neutron diffusion theory code (WIGLE) to simulate the SEFOR transient tests. As an aid to detailed planning of the experimental program, the estimated steady state plant performance characteristics are being determined. An estimate was made of the error in the Doppler temperature coefficient due to a systematic error in the reactor heat balance. An estimate was made of the reactivity effect due to core motion caused by thermal expansion of the core support structure. The composition of the SEFOR mock-up currently being loaded in ZPR-III is described. Pre-experimental predicted results are listed for each experiment. The critical mass is predicted for two ^{239}Pu fission cross section sets. For BNL-325 normalized values, the predicted ^{239}Pu critical mass is 286 kg. Using the recent White-James fission cross section data, the predicted critical mass is 315 kg. All predictions are based on ν values normalized to $\nu_{thermal} = 2.43$ for ^{235}U. Noise measurements being made at the National Reactor Testing Station for the SEFOR program show a significant advantage for the use of the cross-correlation analysis over the auto-correlation analysis. Preparation is under way to test the method for measuring $1/\beta$ in the SEFOR mock-up. Irradiation of test Capsule 2B was completed with a total of 860 small power oscillations (±12.6 percent) at a nominal power of 23 kW/ft. Post-irradiation examination was completed on Capsules 1E (10 hours at 25 kW/ft), 1C (100 large power cycles, 12 to 27 kW/ft), 2A (825 power oscillations at 25 kW/ft), and 1B (11 transients in TREAT). Fabrication of Group III capsules (fuel melting studies) was initiated and conceptual design of the Group IV flux filter capsules was completed. X-ray analysis of the interior and exterior of a pellet was completed. Only $(Pu,U)O_2$ was detected. Tests on hard-fired thoria insulated W,Re thermocouples indicate that insulator electrical shunting decreases the indicated temperature at 4700°F by 5 percent for both 1-and 3-inch immersion depths with both 99 and 99.9 percent pure thoria and that measurements are reproducible with ±1.5 percent. Out-of-pile mixed oxide compatibility tests with tungsten–26 percent rhenium (W26Re) indicate no attack at 2730°F for over 500 hours and severe, localized grain boundary attack at 4700°F after 38 hours. Fabrication of the in-pile thermocouple transmutation experiment (41A) is nearly complete. Detailed design is in progress on in-pile experiments to study thermocouple insulator degradation (41B), precision thermometry (41C), thermocouple response and fuel interaction (41D), and thermocouple life and fuel interaction (41E). Design work on the instrumented fuel assembly, components, and fixtures was completed. Test work, fabrication, and modification work continue. Assembly of the $\frac{1}{6}$ core mock-up was completed and room temperature testing is in progress. Assembly of the sodium flow test is in progress. The tightener rod wear test is in progress. Fabrication was essentially completed on the test rig, control panel, and specimens for the thermal shock tests. Design of the test equipment for the sodium heat transfer tests is complete and procurement of parts is in progress. The FRED test model setup was completed. This included the installation of the device and the instrumentation with connection to the control panel and oscillograph. The test program has started and is involved in checkout and scoping tests to set up a basic test program for performance tests. One of the preliminary tests indicated a 20-inch travel in 92 milliseconds. The detail design of the oscillator mechanism was completed and fabrication is in progress. The variable starting position device which is planned for use with the FRED is being adapted for use as the oscillator positioning drive. The preliminary design of the balanced oscillator control system has started. The tests on the fuel rod grapple, vessel seal, and direct drive torque tool were conducted. The tests on the fuel rod grapple were completed and the results indicate that this tool has performed well under typical environmental conditions. Updating of the 60-group SEFOR cross sections was completed. These cross sections were condensed to 18 groups for one-dimensional design calculations. The smeared fuel density has been increased from 86 percent to 89 percent. New values of volume fractions and atom densities were calculated. A comparison of recent (1964) ^{238}U resonance-parameter data with the 1959 data previously used showed increased self-shielding, which improves the SEFOR physics parameters. Methods were developed for the analysis of segmented fuel designs in slab, cylindrical, and spherical geometries. The HELM computer code was written to calculate macroscopic cross sections compatible with PDQ-4 input from available microscopic cross section files. Dummy core components for use in R and D tests were completed. Two core elements were assembled. Installation and removal tests were made on the fuel rod-extension rod connector pin. Reported data on BeO shows that swelling up to 9 vol % and gas release of 0.1 cc/gm may be expected in 10^{21} nvt (E ≥ 1 MeV) irradiations. The cladding thickness for the reference fuel design was reduced from 55 mils to 40 mils. This reduction in cladding thickness was accomplished by reducing the outside diameter of the cladding 30 mils (from 1.0 inch to 0.97 inch). The reduction in cladding wall thickness reduces the thermal stresses in the cladding, reduces the refueling problems by increasing the clearance between the fuel rod and its supporting structure, and improves the flow distribution within the fuel channel. Consideration is being given to the use of end-dished pellets to reduce the axial thermal expansion of the fuel. (M.O.W.)

28831 (IAE–986) PERSPEKTIVY RAZVITIYA ISSLEDOVATEL'SKIKH REAKTOROV. (Prospects for Development of Research Reactors). Feinberg, S. M. (Institut Atomnoi Energii, Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). 1965. 46p. Dep. mn.

It is pointed out that reactors operating on intermediate energy neutrons can supply high fast neutron and also high slow neutron fluxes at a considerably lower reactor power with the use of beryllium or D_2O flux traps than can conventional, thermal neutron reactors. The neutron spectrum can be varied considerably. The reactor core can be designed to give high heat transfer rates per unit volume, and hence, higher useful fluxes per unit of reactor power. The design and operation of a 50 megawatt SM reactor is described. The critical mass is 11 kg without the fuel channels and 13.5 kg of 90% enriched uranium with the experimental channels. The heat flux from the CM-2 fuel elements is 10^7 kcal m^{-2} hr^{-1}, which exceeds the maximum heat flux in the reactor by a factor of two. The radial fission heat distribution is plotted with the use of Be and D_2O neutron

traps as a function of average ^{235}U burnup. The thermal neutron flux in the trap is about 2.5×10^{15} neutrons cm^{-2} sec^{-1} at 50 megawatt power. The fast neutron (>1 Mev) flux is better than 10^{15} neutrons cm^{-2} sec^{-1}. These fluxes are being increased by a factor of two by improving the design. Neutron flux distributions are plotted. Design of a pulse reactor to obtain high fluxes of neutrinos is discussed. The pulsed reactor power is about 2.5×10^9 kw. The pulse neutrons are absorbed in a block of ^7Li surrounding the reactor core. (TTT)

28832 (IAE–991) OPYT EKSPLUATATSII REAKTORA MR I PROVEDENIE ISPYTANII TVEL I MATERIALOV. (Experience in Operating a Material Testing Reactor and Conducting Tests of Fuel Elements and Various Materials). Goncharov, V. V.; Babulevich, E. N.; Shavrov, P. I. (and others) (Institut Atomnoi Energii, Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). 1965. 44p. Dep. mn.

The Materials Reactor (MR) with a peak power of 30 megawatts is designed to test fuel elements and other reactor materials. The reactor has a total of 28 operating fuel element channels. Flexibility is built into the reactor with movable fuel assemblies. Separate beryllium and graphite reflector blocks can be removed from around the reactor core in order to create large-sized experimental cells. Dangerous operations can be carried out under a layer of water. The loop circuits are reliable in operation and do not leak due to the use of packless pumps and bellows valves. The beryllium reflectors give high thermal neutron fluxes of up to 5×10^{14} neutrons cm^{-2} sec^{-1} without a decrease in the number of fuel element channels in the core. The fuel burn-up distribution, measurements of rod worth, fast neutron flux measurements by the $^{31}P(n,p)^{31}Si$ reaction, the control and safety rod arrangement in the reactor, the cooling water design, the water purification system by ion-exchange, the perturbations in neutron flux due to the large number of loops and fuel element channels, and the variations in heat flux are discussed for this reactor. The power in any loop or fuel element channel can be maintained to an accuracy of 5 to 10%. The heat flux can be varied by ±30% with the use of the movable fuel assemblies. The radiation detection equipment is described. (TTT)

28833 (IDO–14661, pp 83-97) REACTOR TECHNOLOGY SUPPORT. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.).

Loss-of-Fluid Test (LOFT) assistance studies were directed at studying coating materials for the interior of the reactor containment building and decontamination techniques which will permit early reentry after release of fission products associated with reactor core meltdown. High-pressure sprays were effective in removing I from organic coatings which are penetrated deeply by the contaminant; high-pressure steam was effective in some cases. A simulated reactor containment shell for contamination-decontamination experiments, in which coatings and decontamination techniques can be tested in the presence of fission products released from fuel meltdown, is being constructed in a shielded cell. In other reactor support studies, surface contamination (principally ^{60}Co in a HfO_2 layer) was removed from Hf control rods by immersion in molten NaOH; no attack of the metal base was evident. Irradiated Al-clad elements were cleaned of surface contamination by immersion in hot solutions of 0.5M phosphoric acid –0.001M chromium trioxide, followed by immersion in hot 3.0M nitric acid. Decontamination factors of >200 were obtained, but the Al surface was corroded. Results of the decontamination of test reactor loops were also evaluated. (auth)

28834 (JUL–316-RE) TEMPERATUREN ABGEBRANNTER BRENNSTOFFELEMENTE DES REAKTORS FRJ-2 AUSSERHALB DES REAKTORS. (Temperatures of Burned-up Fuel Elements of the FRJ-2 Reactor Outside the Reactor). Paul, H.-G. (Kernforschungsanlage, Juelich (West Germany). Zentralabteilung Forschungsreaktoren). Nov. 1965. 44p. Dep. mn.

The temperatures of burned up fuel elements of the Mark II c type of the FRJ-2 (DIDO) reactor, which were cooled outside the reactor in a cooling tank with gas, were calculated. Two cases were considered: cooling with forced flow of the coolant gas and cooling with free flow of the coolant gas. (J.S.R.)

28835 (JUL–333-RE) TEMPERATUREN UND KRITISCHE (BURN-OUT) LEISTUNG EINES BRENNSTOFFELEMENTES DES REAKTORS FRJ-2 (DIDO) BEI EINER BEGRENZTEN LEISTUNGSEXKURSION. (Temperatures and Critical (Burnout) Power of a Fuel Element of the FRJ-2 (DIDO) Reactor in a Limited Power Excursion). Paul, H.-G. (Kernforschungsanlage, Juelich (West Germany). Zentralabteilung Forschungsreaktoren). Nov. 1965. 32p. Dep. mn.

The temperatures and burn-out of a fuel element of the FRJ-2 reactor were calculated for a reactor power of 60 Mw. The results obtained are graphed. (J.S.R.)

28836 (JUL–338-NP) DAS DREHKRISTALL-FLUGZEITSPEKTROMETER FUER SUBTHERMISCHE NEUTRONEN AM FRJ-2. (The Rotating Crystal Time-of-Flight Spectrometer for Subthermal Neutrons of the FRJ-2). Axmann, A.; Gissler, W. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Neutronenphysik). Dec. 1965. 20p. Dep. mn.

The construction and operation of the rotating crystal time-of-flight spectrometer for subthermal neutrons is described. The rotating crystal is considered in some detail. The counter and electronic equipment are indicated. The resolution of the spectrometer was calculated. The methods used for the data processing are reviewed. The first measurements carried out with the time-of-flight spectrometer had the purpose of detecting the low energy transitions found previously on aqueous hydrofluoric solutions with the inverse beryllium filter method. (J.S.R.)

28837 (ORNL-P–1986) THE ACOUSTIC CHARACTERISTICS OF THE OAK RIDGE REACTOR. Saxe, R. F. (Oak Ridge National Lab., Tenn.). [1965]. Contract W-7405-eng-26. 12p. (CONF-660206–8). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From Symposium on Neutron Noise, Waves, and Pulse Propagation, Gainesville, Fla.

A crystal microphone was used to detect and measure the spectra of acoustical radiations from the ORR for the purpose of detecting nucleate boiling in the reactor. The experimental technique is briefly outlined and the results are discussed. (M.O.W.)

28838 (ORNL-TM–1532) OPERATING SAFETY LIMITS FOR THE HIGH FLUX ISOTOPE REACTOR (HFIR) (100 Mw MAXIMUM POWER). (Oak Ridge National Lab., Tenn.). May 16, 1966. Contract W-7405-eng-26. 11p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Safety limits for operation of HFIR are given for the containment system, reactor core, and control and instrumentation requirements. Also safety limits for experiments, primary systems, and radiation monitoring are given. (M.O.W.)

28839 (WNY–017) PULSTAR PULSE TESTS. Lumb, R. F.; Mac Phee, J. (Western New York Nuclear Research Center, Inc., Buffalo). Oct. 9, 1964. 72p.

Steady state tests, transient tests, and proposed operating limits for the PULSTAR reactor are described. The steady state and transient tests are concerned primarily with the operating performance of the reactor, its bearing on the operational safety of the facility, and the relationship of the test results to the understanding of the basic mechanisms which govern core behavior. (M.O.W.)

28840 FAST NEUTRON FLUX MEASUREMENT FOR THE IRT-2000 REACTOR. Baltmugur, K. K.; Gubatova, D. Ya.; Kemer, R. Ya. At. Energ. (USSR), 20: 155-7 (Feb. 1966). (In Russian).

The fast-neutron flux in the IRT-2000 reactor was measured in both vertical and central channels. The results were compared with similar results for the IRT-1000 reactor. The experimental fast-neutron spectrum was found

to be in close agreement with theoretical predictions. (G.O.Y.)

28841 DESIGN OF A LOW-TEMPERATURE CHANNEL FOR THE VVR-M REACTOR OF THE PHYSICO-TECHNICAL INSTITUTE AT THE USSR ACADEMY OF SCIENCES. Novikov, S. R.; Konopleva, R. F.; Kruglikov, A. N.; Nazarenko, A. N. At. Energ. (USSR), 20: 275-7(Mar. 1966). (In Russian).

A liquid nitrogen-cooled channel that was designed for the VVR-M reactor is described. (D.C.W.)

28842 RESEARCH AND TEACHING WITH UNIVERSITY REACTORS. A EUROPEAN SURVEY. EuroNuclear, 3: 173-82(Apr. 1966).

A survey of European university reactors is given. A list is given of these reactors including their types, location, name, power, and the time when they became critical. Diagrams of the main types of the university reactors are shown. (J.F.P.)

28843 INSTRUMENTED IRRADIATION FACILITIES (LOOPS AND RIGS) FOR MATERIAL TESTS IN REACTORS. Fischer, E. (Institut fuer Reaktorphysik der Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Geesthacht, Ger.). Kerntechnik, 8: 153-8(Apr. 1966). (In German).

The irradiation facilities developed in the German Republic are reviewed and specific examples are given. The characteristics of loops and capsules are compared. The present tendencies in the development of new irradiation facilities are discussed. (J.S.R.)

28844 DESIGN AND THERMAL CHARACTERISTICS OF AN IRRADIATION RIG FOR SOLID SPECIMENS. Ahlf, J.; Anders, D.; Benefeld, R. (Institut fuer Reaktorphysik der Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Geesthacht, Ger.). Kerntechnik, 8: 173-4(Apr. 1966). (In German).

The design and thermal characteristics of an irradiation rig used for the study of the radiation effects on solid samples of nonfissionable materials in the temperature range from 250 and 800°C are described. A sketch is given of the capsule. (J.S.R.)

28845 HIGH-PRECISION TEMPERATURE CONTROL FOR MATERIAL-IRRADIATION TESTS. Seysener, B. (EURATOM, Brussels); Strobel, J.; Wahrendorff, G. Kerntechnik, 8: 175-7(Apr. 1966). (In German).

The device used for the high precision temperature control in material irradiation tests is described. The principle of set point deviation measuring is discussed and the control techniques used are described. The construction and operation of the device is considered. (J.S.R.)

28846 RESEARCH REACTOR FAULT ANALYSIS, PART 2. Moore, J. C. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Eng., 11: 306-10(Apr. 1966).

The methods of classifying and presenting data on fault incidence, the theoretical basis for correlating calculations and techniques used for major and minor fault analysis are discussed. A study of time incidence and the validity of computing plant availability and reliability and their relevance to maintenance practice are considered. (auth)

28847 SOME DESIGN, CONSTRUCTIONAL, AND OPERATIONAL PROBLEMS OF IRRADIATION DEVICES USED FOR TESTING NUCLEAR MATERIALS. Dragomir, I.; Glanz, G. (Inst. of Atomic Physics, Bucharest). Studii Cercet. Fiz., 17: 1151-74(1965). (In Rumanian).

Nuclear materials must be tested within a very broad range of temperature, ranging from liquid helium or liquid nitrogen temperatures to that prevailing in power reactors, both during and after irradiation. Therefore, specialized devices were designed for these unique conditions. The problems encountered include selection of the irradion devices, the temperature measurement and control system to be used, ensuring leak tightness of the system, proper choice of the location within the reactor for the exposure and establishment of the required safety measures. The devices must be able to withstand integrated fluxes of the order of 10^{20} to 10^{22} n/cm^2 and must possess high chemical and mechanical stability. No interaction with the specimens should take place; this requirement is of special importance in the testing of liquid metals. They should possess a sufficiently high thermal resistance to permit establishment of the desired temperatures; in addition, their absorption cross section must be low. Examples are chosen from the literature to indicate how the above problems were solved in practice. (TTT)

28848 FAST CHOPPER WITH ADJUSTABLE SLIT FOR STUDYING RESONANCE NEUTRONS. PART III. COUNTERS. Constantinescu, M.; Cristea, G.; Dobrescu, S.; Mateiciuc, V.; Olteanu, I.; Stadnicov, T. (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz., 18: 117-31(1966). (In Rumanian).

The fast chopper installed in one of the horizontal beamholes of the VVR-S reactor was designed to operate in the neutron energy range from 0.05 to 10,000 ev with an optimum resolution of 0.025 μsec/m. The light intensity may be adjusted within a ratio of 1:19 and the width of the slit may be varied from 0.2 to 1.25 mm. Two types of detectors were used with the chopper: a set of twenty BF_3-filled proportional counters with a surface equal to that of the neutron beam at a distance of 125 m (13 × 45 cm^2), and four Zeiss photomultipliers with boron scintillators which are highly efficient with respect to γ radiation. Study of neutron resonance parameters requires an energy resolution within 1 to 5% which in turn limits the pulse width and that of the time channel of the analyzer to 1 to 3 μsec. A 400-channel amplitude analyzer with a time-amplitude converter was used to achieve this. In the recording stations, a quartz-stabilized pulse generator with 12.82-μsec time channels was employed for energies below 10 ev; the time-amplitude converter was used at higher energies. The experiments carried out for determining the operational parameters of the chopper are described. (TTT)

28849 MODULAR INSTRUMENTATION FOR MSRE (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1340).

142 drawings.

The instrumentation for the Molten Salt Reactor Experiment (MSRE) includes a plug-in chassis system, decade scaler, amplifiers, fast trip comparator, count rate meter, coincidence matrix monitor, demodulator, temperature servo demand drive, voltage regulator, fission chamber, meter protection unit and drawers for safety channel, rod controller, and wide range counting chamber. (For details, see TID-4100.) (J.F.P.)

28850 METHOD FOR THE IRRADIATION OF SPECIMENS IN A NEUTRON REACTOR. Spillane, Richard; Patton, George (to General Dynamics Corp.). German Patent 1,207,517. Dec. 23, 1965. Priority date Nov. 12, 1959, United States.

The reactor according to patent 1,097,580 comprises a reflector extending about the core, a recess in said reflector which is of annular formation, a movable member for simultaneously supporting, in said recess and within said reflector, a plurality of spaced specimens to be irradiated, means for removing any one specimen when it is located at a selected position, and drive means for rotating the ring-shaped support member about its axis so as to locate any selected specimen at selected positions. In order to obtain a uniform irradiation of the specimens they are rotated about the core in such a way that they are irradiated from all sides of the core. (Gmelin Inst.)

WASTE DISPOSAL AND PROCESSING

See also BIOLOGY AND MEDICINE — Ecology
CHEMISTRY — Radiochemistry
CHEMISTRY — Separation Processes and Procedures
HEALTH AND SAFETY

Refer also to abstract 27035.

28851 (BNWL-SA-57) THE ROLE OF GEOLOGY IN THE DISPOSAL OF RADIOACTIVE WASTES. Brown, D. J.; Haney, W. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb. 28, 1965. Contract AT (45-1)-1830. 19p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

The role of geology in evaluation of disposal sites prior to their use, and how geology is utilized in the interpretation of monitoring results after the disposal facility is put in operation is discussed. Detailed geological and hydrological evaluations of each site to evaluate disposal potential, and the establishment of a monitoring system around the disposal facility to assess the continued safeness of the operation after the site is put in use are given as reasons for the success of the waste management program at Hanford. (P.C.H.)

28852 (IDO-12052) A SYSTEM FOR THE EVALUATION OF LIQUID WASTE DISPOSAL. Hawkins, D. B. (Idaho Operations Office (AEC), Idaho Falls. Health and Safety Div.). Apr. 1966. 46p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

A system is discussed which attempts to combine the cost-hazard aspects of a waste-disposal operation in a logical and useful manner and which shows promise for the evaluation of a dynamic waste-disposal operation. A test case in which waste is discharged either to the ground via a seepage pond or to the water table via a well was evaluated. In this example, the hazards were appraised; the fixed costs including monitoring costs were tabulated; and the probable costs, i.e., those costs which ensue if a given event occurs, were evaluated using estimates of the probability of occurrence of various hazardous events. The probability estimates were subjective estimates of the evaluator who drew upon the geologic, hydrologic, and chemical information available. The probable costs and fixed costs were tabulated in a statistical cost table, which was used in conjunction with the hazard evaluation to choose the optimum method of disposal. (P.C.H.)

28853 (IDO-14661, pp 45-82) WASTE MANAGEMENT. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.).

The design and operation of a waste calcining facility are described. Information is included on processing high-level aqueous wastes, solids storage design, and corrosion of process equipment. Results of laboratory and pilot plant studies in support of the waste calcining facility are presented, and measurements of heat dissipation from buried waste are discussed. Investigations of water-filled basins for fuel storage, fission product leakage from fuels, basin water decontamination, and fuel cladding corrosion by basin water are reported. (J.R.D.)

28854 (RFP-735) INCINERATION OF PLUTONIUM CONTAMINATED WASTE MATERIALS. A Preliminary Study for Replacement of the Existing Rocky Flats Incinerator. Foster, R. S. (Rocky Flats Div., Dow Chemical Co., Golden, Colo.). May 9, 1966. Contract AT(29-1)-1106. 27p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

Present contaminated waste incinerator design trends are presented along with references to recent incineration literature. Constant heat release is recommended as a basis for design of waste incinerators. Incineration costs were found to be only a small portion of overall costs associated with recovery of plutonium from combustible wastes. (auth)

28855 UTILIZATION OF CHEMICAL REACTOR HEAT FOR THERMAL REPROCESSING OF LIQUID RADIOACTIVE WASTES. Vereskunov, V. G.; Zakharova, K. P.; Kulichenko, V. V.; Zimakov, P. V. At. Energ. (USSR), 20: 277-9(Mar. 1966). (In Russian).

A method of using chemical heat in the thermal reprocessing of liquid radioactive wastes is described, which is based on the equation $Me_mO_n + qMe' \rightarrow Me'_qO_n + mMe + Q$, where Me_mO_n and Me' are, respectively, the oxidation and reduction products usually involved. (G.O.Y.)

28856 DISPOSAL OF RADIOACTIVE WASTES BY HYDRAULIC FRACTURING. PART I. GENERAL CONCEPT AND FIRST FIELD EXPERIMENTS. De Laguna, Wallace (Oak Ridge National Lab., Tenn.). Nucl. Eng. Design, 3: 338-52(1966).

The feasibility of radioactive waste disposal by hydraulic fracturing was demonstrated. This disposal method is an adaptation of hydraulic fracturing techniques used in the petroleum industry and is aimed at replacing current methods of shallow-ground disposal. A number of problems had to be solved in the development of this method. First, it had to be shown that the fractures formed in shales at Oak Ridge would follow the bedding planes, and not break up vertically toward the surface. This was done, as is described. (auth)

28857 DISPOSAL OF RADIOACTIVE WASTES BY HYDRAULIC FRACTURING. PART II. MECHANICS OF FRACTURE FORMATION AND DESIGN OF OBSERVATION AND MONITORING WELLS. De Laguna, Wallace (Oak Ridge National Lab., Tenn.). Nucl. Eng. Design, 3: 432-8 (Apr. 1966). (ORNL-P-1876).

One of the problems associated with disposal by hydraulic fracturing concerns methods of monitoring at the surface for evidence of fracture orientation underground. Monitoring and observation wells had to be designed and tested which would give assurance that, as fracture after fracture was filled with waste, no change in the fracture pattern or failure in the permeability of the cover rock would result. Prototypes of two kinds of wells designed to provide such assurance were tested with sufficient success to show that the basic designs are sound, although certain improvements will be required. In particular, a better understanding of the complex rock mechanics of the operation is needed to make best use of several monitoring techniques available. (auth)

28858 STACK MONITORING INSTRUMENTATION /Q-2285/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1290).

16 drawings.

As part of the stack monitoring system, an instack sampler was located in a laboratory fume stack in building 3039 at the Oak Ridge National Laboratory. Samples are collected from cell-ventilation air and process-vessel offgases discharged through the stack from several buildings. (For details, see TID-4100). (F.L.S.)

GENERAL AND MISCELLANEOUS

28859 (BNL–943) BIBLIOGRAPHY OF TECHNICAL PUBLICATIONS AND REPORTS OF THE RADIATION DIVISION, BROOKHAVEN NATIONAL LABORATORY, JANUARY 1963–JUNE 1965 INCLUSIVE. Ballantine, D. S.; Kopp, L. E. (Brookhaven National Lab., Upton, N. Y.). July 1965. Contract AT(30-2)-Gen-16. 5p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Eighty references on radiation source technology and dosimetry and radiation applications and research are given to reports, journals, and books published from Jan. 1963 through June 1965. (P.C.H.)

28860 (BNWL–113-15) PLUTONIUM ABSTRACTS. Volume 6, Number 3. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 30, 1966. Contract AT(45-1)-1830. 39p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

Seventy-two references are given to journals and reports published from 1964 through March 1966. The subjects covered include: biology and medicine; chemistry; health and safety; metallurgy and ceramics; physics; reactor technology; and miscellaneous. (P.C.H.)

28861 (BNWL–218) TECHNICAL PUBLICATIONS OF BATTELLE-NORTHWEST DURING 1965. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 1966. Contract AT(45-1)-1830. 52p. Dep. mn. CFSTI $3.00 cy, $0.50 mn.

Included is a list of research and development reports and technical articles published during 1965 by Battelle-Northwest. Specific subject areas included are: biology and medicine, chemistry and chemical engineering, earth and atmospheric sciences, electronics and computer technology, engineering and equipment, health and safety, metals, ceramics, and materials, physics, radiation effects, and reactor technology. (M.O.W.)

28862 (CONF-651131) PROCEEDINGS OF FIRST AD-HOC FORUM OF SCIENTIFIC AND TECHNICAL INFORMATION ANALYSIS CENTER MANAGERS, DIRECTORS, AND PROFESSIONAL ANALYSTS, HELD AT BATTELLE MEMORIAL INSTITUTE, COLUMBUS, OHIO, NOVEMBER 9–11, 1965. (Battelle Memorial Inst., Columbus, Ohio. Oak Ridge National Lab., Tenn.). Contracts W-7405-eng-92; W-7405-eng-26. 185p. Dep. mn. CFSTI $2.00 cy, $1.00 mn.

Fourteen articles are included on information centers and their organization, management, and problems. The main theme of the conference was information analysis center operation. (P.C.H.)

28863 (CONF-651131(App.)) DIRECTORY OF SELECTED SPECIALIZED INFORMATION SERVICES, AD-HOC FORUM OF SCIENTIFIC AND TECHNICAL INFORMATION ANALYSIS CENTER MANAGERS, DIRECTORS, AND PROFESSIONAL ANALYSTS, HELD AT BATTELLE MEMORIAL INSTITUTE, COLUMBUS, OHIO, NOVEMBER 9–11, 1965. (Battelle Memorial Inst., Columbus, Ohio. Oak Ridge National Lab., Tenn.). Contracts W-7405-eng-92; W-7405-eng-26. 130p. Dep. mn. CFSTI $1.50 cy, $1.00 mn.

Brief descriptions of the information service activities of 65 different organizations or projects are given. Also, some element of specialization in subject area, type of service provided, or some other aspect is reported for each project. Indexes are included for list of organizations, staff members, location, and subjects. (P.C.H.)

28864 (NP–15976) JAHRESBERICHT, 1964. (Annual Report, 1964). (Kernforschungsanlage, Juelich (West Germany)). 179p. Dep. mn.

The basic organization and services of the Juelich Nuclear Research Installation are outlined. Contributions of the installation to the third Geneva conference in 1964 are given. The contributions of the Juelich Nuclear Research Installation to the gas-cooled high-temperature Th reactor project include material studies on carbides, devices for irradiation research at the DIDO reactor, and preliminary studies on irradiated fuel elements. Developments are reported on radioinduced changes in organisms, studies on radiation sensitivity, growth physiology, wheat radiation resistance, genetic and evolutionary effects of radioinduced mutations, molecular evolutions, the effect of sub-lethal radiation doses on chicken heart muscle, delayed effects in irradiated chicken embryos, basic research in cytology, enrichment and use of stable isotopes, actinide chemistry, studies of nuclear recoils and their chemical effects, activation analysis with neutrons, technetium chemistry, polarographic studies on pertechnetates, thermodynamics of the U–O–C system, dissolution of fine-grained fuel and breeder materials in acids, electrolysis of U compounds, studies in high energy physics, studies in nuclear physics, the physics of slow neutrons, nuclear physics with reactor neutrons, MHD studies, reactor construction materials, reactor development, effect of irradiation on the pattern of precipitation processes in Al alloys, theory of radiation damage, plasma physics, and reactor experiments. The electronics developed for specific experiments are indicated, and the radiation protection methods used are discussed. The scientific publications are tabulated. (J.S.R.)

28865 (PNE-481) ENVIRONMENT OF CAPE THOMPSON REGION, ALASKA. [Summary of Project Chariot]. (Division of Peaceful Nuclear Explosives, AEC. Division of Biology and Medicine, AEC). [nd].

Information is given on physical characteristics and bio-environment of the land, coast, and Chukchi Sea and biotic systems on land, the people, and radioactivity in the Cape Thompson Region, Alaska. (P.C.H.)

28866 (UCRL–14619) EFFECT OF STRAIN RATE AND SPECIMEN DIMENSIONS ON THE YIELD POINT OF MILD STEEL [Thesis]. Hamstad, Marvin A. (Lawrence Radiation Lab., Univ. of California, Livermore). Apr. 25, 1966. Contract W-7405-eng-48. 46p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

Submitted to Illinois Inst. of Tech., Chicago.

Three series of tensile tests were performed on 1014 mild steel to determine how the yield point was affected by specimen geometry at different strain rates. The strain rates to yielding were approximately 10^{-6}, 10^{-4}, and 10^{-2} per sec. In each series the length-to-diameter ratios of the reduced section of the specimens varied from 1.3 to 4.0. It was found that the lower yield point seemed to depend on the specimen gage length during constant crosshead speed tests. Also, the upper yield point exhibited wide scatter under supposedly identical testing conditions, thus precluding its use in the correlation of the data. (P.C.H.)

28867 (UCRL–14752) DIFFUSION OF Fe IN AN Fe–Al ALLOY. Lai, D. Y. F.; Borg, R. J. (Lawrence Radiation Lab., Univ. of California, Livermore). Mar. 24, 1966. Contract W-7405-eng-48. 5p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Values for the diffusion coefficients of Fe in an alloy containing 5.7 at. % Al are reported. The measurements run from 850 to 1185°C. The activation energy was found to be somewhat higher than was expected. Data are tabulated. (P.C.H.)

28868 WORLD URANIUM AND THORIUM RESOURCES. Paris, European Nuclear Energy Agency, 1965. 22p.

World estimates of the resources of uranium and thorium that are known to exist or which can be estimated or inferred are presented. The figures do not take into consideration resources in the USSR, China, and Eastern Europe. Estimates for uranium were made in three price ranges, $5 to 10, $10 to 15, and $15 to 30 per pound U_3O_8. Estimates for thorium were made only for the $5 to 10 per pound ThO_2 range. The reliability of the estimates is dis-

cussed. Data are presented on uranium for the United States, Canada, South Africa, France, Spain, Portugal, Sweden, Denmark, Morocco, India, Japan, Argentina, Australia, Congo, and Gabon. Data on thorium are presented for the United States, India, Canada, Africa, Australia and southeast Asia, Denmark and Brazil. (M.C.G.)

28869 ATOMIC ENERGY DEVELOPMENTS AND FUTURE URANIUM REQUIREMENTS AS ENVISAGED AT THE THIRD INTERNATIONAL UNITED NATIONS CONFERENCE ON THE PEACEFUL USES OF ATOMIC ENERGY, GENEVA, SEPTEMBER 1964. Roscoe, S. M. Ottawa, Queen's Printer, 1965. 17p. $0.35.

Expansion of the demand for uranium to fuel new thermal power plants is expected not only to restore a rapid rate of extraction of Canada's large known uranium ore reserves within ten years but to present opportunities to exploit deposits as yet not discovered or deposits considered below ore grade at current uranium price levels. Demand for uranium as reactor fuel in projected power plants for the rest of the 20th century is surveyed in detail along with other applications of atomic energy. Other matters incidental to the nuclear industry such as isotope separation and safety are discussed. (F.S.A.)

28870 HEARINGS BEFORE THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, EIGHTY-NINTH CONGRESS, SECOND SESSION ON S. RES. 179 NONPROLIFERATION OF NUCLEAR WEAPONS, FEBRUARY 23, AND MARCH 1 AND 7, 1966. Washington, D. C., Joint Committee on Atomic Energy, 1966. 182p. $0.50 GPO.

CORPORATE AUTHOR INDEX

This index contains entries for this period for all report literature and, in addition, for certain published literature items for which it is felt that a corporate approach is especially desirable, e.g., symposia, conference proceedings, and meetings.

Each entry under a corporate author is a shortened version of the title of the publication, followed by the NSA volume and abstract number. Report numbers are given in parentheses.

The phrase "Progress report" is abbreviated as "Prog. rpt.," permitting a more rapid and complete alphabetical arrangement of the titles without changing the location of the progress report titles in relation to the other titles.

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Because of problems involving the mechanical preparation of this index, all accent marks are omitted. The following changes in spelling have been introduced to reduce some of the confusion which might result from omitting the accents:

ä	becomes	ae
ö		oe
ø		oe
ü		ue (except in transliterated Chinese names)

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SUBJECT INDEX

Main entries in this index are generally specific materials, things, and processes. These are followed by modifiers that describe the properties of, and processes applied to, the main entries.

The number preceding the colon is the *NSA* volume number, and the number following is the abstract number. The designation (R) following the abstract number indicates that the abstract is of a progress report; (P) indicates a patent; and (T) indicates a translation. Abstracts for reports other than progress reports carry no letter designation. References to report numbers, where appropriate, are included after the abstract number of the citation. Published literature (journal article or book) is identifiable by the absence of a report number.

The user should bear in mind that the ideas presented in the original literature, rather than key words, have been indexed. The indexers have tried to select what seemed the most probable and logical place to look for typical information. Since it is not possible to anticipate where a user would look for information, numerous cross references are included in cumulative indexes to assist him in his search.

Experience in using an index of this type will be the best guide in obtaining the desired information, and a consideration of synonymous or closely related terms will prove valuable.

Information must be so indexed as to be of the greatest use to the greatest number of users. This requires that a topic be indexed to headings that most specifically describe it and not ordinarily to the headings that describe its ultimate use, nor to the general class headings that include the specific headings. For example, information on the treatment of thyroid disease with I-131 would be indexed under Thyroid Gland and under Iodine Isotopes I-131, but not necessarily under Radiotherapy. A study of the effects of x radiation on hair would be indexed under both X Radiation and Hair. However, the information would not be indexed under the experimental animal, e.g., Rats, unless the report discusses the effects on rat hair as compared with the effect on the hair of other animals.

The broad, general class headings are used only for general information or for comprehensive reports or articles.

Subject Heading Styles

Generally, the direct form of subject entry is used rather than inverted headings, e.g., Amino Acids rather than Acids, Amino; Helium Isotopes He-4 rather than Helium—isotopes He-4 or Helium—He-4 isotopes. Note, however, that in some cases parenthetic modifying terms or inverted headings of the form Neutrons, Fast are used in preference to a direct entry that would result in the scattering of information. Organic compounds are usually entered in the index in the inverted form so that substituted compounds can be listed near the parent compound; e.g., Benzene, Bromo- rather than Bromobenzene. In general, the style of nomenclature used is that of Chemical Abstracts, except that some items listed in that publication as subheadings are elevated to form part of the main heading; e.g., Butyric Acid, Methyl Ester rather than Butyric Acid—methyl ester.

Alphabetization

Main headings are alphabetized word-by-word. A parenthetic qualifier following a main heading is disregarded in alphabetizing unless there are two or more headings identical except for the parenthetic qualifier, in which case the qualifier determines the order. Headings involving Greek letters are arranged as if the names of the letters were spelled out.

Examples:

M-Capture
  see Electron Capture
Magnesium
Magnesium Alloys
Manganese Fluorides
Manganese(II) Fluorides
Mesons
Mesons (π)
Mesons (ρ)
3-Pentanol, 2,4-Dimethyl-
2-Pentanol, 2-Methyl-
2-Pentanol, 4-Methyl-

Nomenclature of Inorganic Compounds

Inorganic compounds are indexed in the direct form, listing cations in the order of increasing valence in the case of polycationic salts of varying valence and in alphabetic order for polycationic salts in which all cations have the same valence; e.g., Sodium Aluminum Silicates and Potassium Sodium Sulfates.

Multicomponent Alloys and Other Systems

Multicomponent alloys, except well-known trade names, are indexed under a main heading in the form "element alloy" for each element in the alloy. The modifier begins with element symbols for each component arranged alphabetically as if the English name for the element were spelled out.

Example: Copper-Gold Alloy is indexed
  Copper Alloys
    Cu-Au...
  Gold Alloys
    Cu-Au...

Well-known alloys such as Zircaloy-2 are indexed directly to the trade name; cross references referring from each component of the alloy to the entry for the trade name appear in cumulative indexes.

Multicomponent systems of non-metallic elements are indexed in a manner similar to alloys except the main heading used contains the word "Systems" in place of "Alloys."

Example: Silicon–Tungsten Systems are indexed
  Silicon Systems
    Si-W...
  Tungsten Systems
    Si-W...

Multicompound systems and mixtures of compounds are indexed under the main heading for each component com-

pound; the modifiers begin with an alphabetical listing of compound formulas.

Example: Lead Titanate–Lead Zirconate is indexed
Lead Titanates
$PbTiO_3$-$PbZrO_3$...
Lead Zirconates
$PbTiO_3$-$PbZrO_3$...

A mixed system of compounds and elements is indexed using a combined form of the above conventions, e.g., a dispersion of copper and alumina would be indexed

Aluminum Oxides
Al_2O_3-Cu...
Copper Systems
Al_2O_3-Cu..

Physical States and Configurations of Materials

Specification of the physical state, if other than normal, or geometric configuration of the material is included in the modifying phrase, i.e., liquid metals would be indexed to the metal with "liquid" in the modifier, and carbon crucibles would be indexed to Carbon with "crucibles" appropriately placed in the modifier and also to Crucibles if appropriate.

Modifying Phrases

The modifiers appearing under a main heading are written specifically to describe the relation of the item being indexed to that main heading. The modifier, therefore, will generally contain more useful information about that relation than will a title or a phrase written to be used under every main heading assigned to the item. Effort is exerted to begin the modifier with the word judged to be of greatest use to the greatest number of users; this, however, does not obviate the need to consider all modifiers under the main heading(s) of interest.

Modifiers are usually intended to form a meaningful phrase when combined with the main heading. Some are intended to be read following the main heading, e.g., the entry Hydrogen—sorption by charcoal is read "hydrogen sorption by charcoal"; however, as a result of placing the important word first, many modifiers must be arranged for smooth reading, e.g., Formaldehyde—yields in radiolysis of ethyl ether, effects of deuterium on is read "effects of deuterium on formaldehyde yields in radiolysis of ethyl ether" and Uranium—crystal structure of, effect of cooling rate on allotropic transformations in is read "effect of cooling rate on allotropic transformations in crystal structure of uranium." Prepositions are sometimes omitted if no ambiguity results.

Special characters are added to modifiers in the field of physics; if the modifier does not establish the experimental or theoretical character of a reference, a symbol (E), (T), or (E/T) is placed immediately after the modifying phrase and before the journal reference number. The value of this identification has been established by the American Institute of Physics.

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10236	20-27643	Dep. mn. CFSTI $2.00 cy, $0.50 mn
BNL-tr-		
6	20-27111	Dep. mn. CFSTI $3.00 cy, $0.75 mn; JCL $5.60 fs, $1.94 mf
BNWL-		
113-15	20-28860	Dep. mn. CFSTI $2.00 cy, $0.50 mn
184	20-27473	Dep. mn. CFSTI $3.00 cy, $0.75 mn
198	20-27404	Dep. mn. CFSTI $4.00 cy, $1.00 mn
204	20-28828	Dep. mn. CFSTI $1.00 cy, $0.50 mn
207	20-27407	Dep. mn. CFSTI $3.00 cy, $1.00 mn

Report No.	Abstract No.	Availability
218	20-28861	Dep. mn. CFSTI $3.00 cy, $0.50 mn
BNWL-SA-		
22	20-27188	Dep. mn. CFSTI $1.00 cy, $0.50 mn
26	20-27189	Dep. mn. CFSTI $1.00 cy, $0.50 mn
56	20-27578	Dep. mn. CFSTI $1.00 cy, $0.50 mn
57	20-28851	Dep. mn. CFSTI $1.00 cy, $0.50 mn
58	20-26742	Dep. mn. CFSTI $1.00 cy, $0.50 mn
155	20-27190	Dep. mn. CFSTI $1.00 cy, $0.50 mn
190	20-27601	Electrochem. Technol., 4: 240-9(1966)
212	20-27191	Dep. mn. CFSTI $1.00 cy, $0.50 mn
302	20-27344	Rev. Sci. Instrum., 37: 697-709(1966)
493	20-26626	Science, 152: 1062-4(1966)
591	20-26922	Dep. mn. CFSTI $1.00 cy, $0.50 mn
616	20-28714	Dep. mn. CFSTI $1.00 cy, $0.50 mn
646	20-27120	Dep. mn. CFSTI $1.00 cy, $0.50 mn
650	20-27144	Dep. mn. CFSTI $1.00 cy, $0.50 mn
655	20-28692	Dep. mn. CFSTI $1.00 cy, $0.50 mn
671	20-27192	Dep. mn. CFSTI $1.00 cy, $0.50 mn
678	20-27193	Dep. mn. CFSTI $1.00 cy, $0.50 mn
CALT-		
68-56	20-28020	Phys. Rev., 145: 1287-1301(1966)
CAPE-		
1284	20-27349	
1290	20-28858	
1297	20-27246	
1298	20-27247	
1299	20-27353	
1302	20-27352	
1303	20-27351	
1306	20-27354	
1333	20-27350	
1334	20-27249	
1336p	20-27250	
1340	20-28849	
1349	20-27248	
CEA-R-	**(French)**	
2885	20-27258	Dep. mn
2940	20-28693	Dep. mn
2941	20-27478	Dep. mn
2949	20-26637	Dep. mn
2997	20-27441	Dep. mn
CEA-tr-	**(French)**	
A-1871	20-27269	Dep. mn. JCL $4.60 fs, $1.52 mf
CERN-	**(European Organization for Nuclear Research)**	
66-17	20-27259	Dep. mn
CLM-R-	**(British)**	
53	20-28482	Dep. mn. BIS $1.20. HMSO 6s.
55	20-28483	Dep. mn. BIS $0.90. HMSO 4s. 6d.
56	20-28041	Dep. mn. BIS $0.50. HMSO 2s. 6d.
CONF-179-	**(American Chemical Society Radionuclidic Exchange on Soils, Minerals, and Resins, Philadelphia, Apr. 1964)**	
21	20-26744	See HW-SA-3099
CONF-489-	**20-28684**	**(5th International Symposium on the Reactivity of Solids, Munich, Aug. 1964) New York, Elsevier Publishing Co., 1965**
CONF-640704-	**(4th International Symposium on Rarefied Gasdynamics, Toronto, July 1964)**	
Vol.1	20-28091	$19.50
Vol.2	20-28090	$18.50
CONF-640929-	**20-28140**	**(International Conference on the Earth Sciences, Cambridge, Mass., Sept. 30–Oct. 2, 1964) $20.00**
CONF-641109-	**20-27380**	**(International Congress on Application of Large Radiation Sources in Industry, Amsterdam, Nov. 12–13, 1964) The Hague, Nederlands Atoomforum, [1965]**
CONF-650513-	**(American Ceramic Society, Annual Meeting, Philadelphia, May 4, 1965)**	
5	20-27588	See LA-DC-6822
CONF-650636-	**20-15437**	**(International Symposium on Electron and Photon Interactions at High Energies, Hamburg, June 8–12, 1965)**
Vol.II	20-27893	Hamburg, Deutsche Physikalische Gesellschaft e.V., 1966
CONF-650638-	**20-27251**	**(Physics of Quantum Electronics Conference, San Juan, Puerto Rico, June 28–30, 1965) $24.00**
CONF-650710-	**19-43507**	**(American Nuclear Society, Meeting on Reactor Operating Experience, Jackson Lake Lodge, Wyo., July 28–30, 1965)**
5	20-28816	See RL-SA-44
CONF-650726-	**20-27637**	**(12th International Spectroscopy Conference, Exeter, England, July 11–17, 1965) London, Hilger and Watts, Ltd., 1965**
CONF-650804-	**(5th Rare Earth Research Conference, Ames, Iowa, Aug. 30–Sept. 1, 1965)**	
Bk.3	20-26905	ORAU
19	20-26904	ORINS. Gmelin, AED-CONF-65-208-3
25	20-27564	ORAU. Gmelin, AED-CONF-65-208-26
CONF-650806-	**(7th International Conference on Phenomena in Ionized Gases, Belgrade, Aug. 22–27, 1965)**	
23	20-28488	See JUL-314-PP
CONF-650946-	**20-27226**	**(4th High Temperature Liquid-Metal Heat Transfer Technology Conference, Argonne, Ill., Sept. 28–29, 1965) See ANL-7100**
CONF-651017-	**20-25495**	**(Electrochemical Society Meeting, Buffalo, Oct. 10–14, 1965) Electrochem. Technol., 4: 77-162(1966)**
Pt.2	20-27420	Electrochem. Technol., 4: 193-274(1966)
12	20-27439	ORAU. Gmelin, AED-CONF-65-289-17
CONF-651030-	**(German Physical Society, Annual Meeting, Frankfurt, Oct. 4–9, 1965)**	
Abst.	20-27638	Munich, Deutsche Physikalische Gesellschaft e.V., 1965
Vol.1	20-27640	Stuttgart, B. G. Teubner Verlagsgesellschaft mbH, 1965
Vol.2	20-27639	Stuttgart, B. G. Teubner Verlagsgesellschaft mbH, 1965
CONF-651052-	**(Indiana Academy of Sciences, 81st Annual Meeting, Notre Dame, Ind., Oct. 7–9, 1965)**	
1	20-26999	ORAU. Gmelin, AED-CONF-65-283-1
CONF-651072-	**(American Society of Tool and Mfg. Engineers, Chapter 107, Knoxville, Tenn., Oct. 7 and Nov. 4, 1965)**	
1	20-27122	See Y-KE-194
CONF-651111-	**20-27000**	**(Symposium in Medicine No. 9 Radioactive Pharmaceuticals, Oak Ridge, Tenn., Nov. 1–4, 1965) Dep. mn. CFSTI $5.00 cy, $3.00 mn**
CONF-651131-	**20-28862**	**(1st AD-HOC Forum of Scientific and Technical Information Analysis Center Managers, Directors, and Professional Analysts, Columbus, Ohio, Nov. 9–11, 1965) Dep. mn. CFSTI $2.00 cy, $1.00 mn**
App.	20-28863	Dep. mn. CFSTI $1.50 cy, $1.00 mn
CONF-651135-	**(American Physical Society, Southeastern Section, Charlottesville, Va., Nov. 1–3, 1965)**	
5	20-27392	See ORNL-TM-1475
CONF-651202-	**(Symposium on Practices in the Treatment of Low and Intermediate Level Radioactive Waste, Vienna, Dec. 6–10, 1965) .**	
19	20-27039	See NP-15946
CONF-660107-	**(American Physical Society Meeting, New York, Jan. 26–29, 1966)**	

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39	20-27804	See UCRL-16767
CONF-660113–	**(Mössbauer Symposium, New York, Jan. 25, 1966)**	
1	20-28606	See LA-DC-7561
CONF-660205–	**(Metallurgical Society of the American Institute of Mining, Metallurgical, and Petroleum Engineers, New York, Feb. 1966)**	
5	20-28738	See AECL-2534
CONF-660206–	**(Symposium on Neutron Noise, Waves, and Pulse Propagation, Gainesville, Feb. 14–16, 1966)**	
8	20-28837	See ORNL-P-1986
12	20-28719	See JAERI-Memo-2190
CONF-660209–	**(Conference on Intermediate Energy Physics, Williamsburg, Va., Feb. 9–11, 1966)**	
4	20-28267	See BNL-10135
CONF-660218–	**(Meeting of the American Crystallographic Assn., Austin, Tex., Feb. 28–Mar. 2, 1966)**	
1	20-28603	See BNL-10134
CONF-660303–	**(American Physical Society, Conference of Neutron Cross Section Technology, Washington, D. C., Mar. 22–24, 1966)**	
29	20-28282	See ORNL-P-2091
31	20-28714	See BNWL-SA-616
CONF-660304–	**(Institute of Electrical and Electronics Engineers, Scintillation and Semiconductor Counter Symposium, Washington, D. C., Mar. 2–4, 1966)**	
9	20-28608	See NYO-3408-5
CONF-660306–	**(American Physical Society, Conference on Isobaric Spin, Tallahassee, Mar. 17–19, 1966)**	
6	20-28281	See ORNL-P-2074
7	20-28269	See BNL-10196
CONF-660312–	**(Nederlands Atoomforum, Utrecht, Netherlands, Mar. 15, 1966)**	
6	20-28172	See BNL-10147
CONF-660319–	**(American Society for Metals Sessions, WESTEC Conference, Los Angeles, Mar. 1966)**	
1	20-27471	See ACF-17
CONF-660324–	**(26th Annual Conference on Physical Electronics, Cambridge, Mass., Mar. 21–23, 1966)**	
1	20-27788	See UCRL-16804
2	20-27789	See UCRL-16805
CONF-660403–	**(International Symposium on Radiological Protection of the Worker by the Design and Control of His Environment, Bournemouth, England, Apr. 18–22, 1966)**	
3	20-27197	See HASL-175
CONF-660405–	**(Symposium on Radioecological Concentration Processes, Stockholm, Apr. 25–29, 1966)**	
6	20-26599	See NP-16002, Paper 3
7	20-26600	See NP-16002, Paper 4
8	20-26601	See NP-16002, Paper 5
9	20-26602	See NP-16002, Paper 6
10	20-26603	See NP-16002, Paper 7
11	20-26604	See NP-16002, Paper 8
12	20-26605	See NP-16002, Paper 9
14	20-27194	Dep. mn. CFSTI $1.00 cy, $0.50 mn
CONF-660406–	**(ASME Metals Engineering Conference and AWS 47th Annual Meeting and Welding Exposition, Cleveland, Apr. 18–21, 1966)**	
1	20-27479	Dep. mn. CFSTI $2.00 cy, $0.50 mn
CONF-660409–	**(Libby/Cockcroft Meeting on Graphite Chemistry, Harwell, England, Apr. 25–26, 1966)**	
2	20-26922	See BNWL-SA-591
CONF-660414–	**(2nd International Conference on Electron and Ion Beam Science and Technology, New York, Apr. 17–20, 1966)**	
1	20-27414	See ORNL-P-2108
CONF-660415–	**(22nd Annual Conference of the National Assn. of Corrosion Engineers, Miami Beach, Apr. 1966)**	
1	20-26920	See AECL-2562
CONF-660416–	**(Pacific Northwest Metals and Minerals Conference, Seattle, Apr. 21–22, 1966)**	
1	20-27144	See BNWL-SA-650
CONF-660503–	**(7th Japanese Conference on Radioisotopes, Tokyo, May 16–19, 1966)**	
2	20-26921	See BNL-10208
CONF-660505–	**20-27419**	**(American Ceramic Society Meeting, Washington, D. C., May 7–12, 1966) Hinsdale, Ill., American Nuclear Society, 1966**
CONF-660511–	**(International Symposium on Capsule Irradiation Experiments, Pleasanton, Calif., May 3–5, 1966)**	
3	20-28754	See LA-DC-7753
CONF-660518–	**(AEC Annual Metallography Meeting, Denver, May 18–20, 1966)**	
1	20-26752	See RFP-765
CONF-660520–	**(International Symposium on the Decontamination of Nuclear Installations, Harwell, England, May 4–6, 1966)**	
2	20-27201	See LA-DC-7590
CONF-660523–	**(21st Annual Purdue Industrial Waste Conference, Lafayette, Ind., May 3–5, 1966)**	
1	20-27193	See BNWL-SA-678
2	20-27192	See BNWL-SA-671
CONF-660526–	**(International Standards Assn., Northwest Instrument Conference and Exhibit, Richland, Wash., May 18, 1966)**	
1	20-27120	See BNWL-SA-646
CONF-660527–	**(Symposium on Use of Computers in Analysis of Experimental Data and Control of Nuclear Facilities, Argonne, Ill., May 3–6, 1966)**	
1	20-28692	See BNWL-SA-655
CONF-660528–	**(9th Modulator Symposium, Fort Monmouth, N. J., May 12, 1966)**	
1	20-27227	See BNL-10214
CONF-660608–	**(2nd AIAA Propulsion Joint Specialist Conference, Colorado Springs, June 13–17, 1966)**	
1	20-27132	See LA-DC-7655
2	20-27133	See LA-DC-7656
4	20-28821	See LA-DC-7641
6	20-28822	See LA-DC-7649
7	20-28820	See LA-DC-7244
CONF-660609–	**(International Symposium on Food Irradiation Meeting, Karlsruhe, Germany, June 6–10, 1966)**	
1	20-27371	See BNL-10174
CONF-660706–	**(3rd Washington State Univ. Pacific Northwest Plastics Workshop Meeting, Richland, Wash., July 14–16, 1966)**	
1	20-27480	See DUN-SA-10
COO–		
7-0369	20-27665	Nucl. Instrum. Methods, 41: 245-54(1966)
881-62	20-27867	Phys. Rev. Lett., 16: 913-17(1966)
1142-64	20-26914	J. Phys. Chem., 70: 1575-8(1966)
1198-297	20-28649	Phys. Rev., 145: 507-18(1966)
1198-313	20-28647	Phys. Rev., 145: 409-11(1966)
1420-123	20-27260	Dep. mn. CFSTI $3.00 cy, $0.75 mn
1528-5	20-26923	Dep. mn. CFSTI $2.00 cy, $0.50 mn
1545-3	20-27873	Phys. Rev. Lett., 16: 956-9(1966)
CRWR–		
3	20-26606	See TID-22870
CTO–	**(Non-AEC)**	
261	20-27721	For translation see NP-tr-1380
CU–	**(Misc.)**	
248	20-27846	Phys. Rev., 145: 1103-11(1966)
249	20-27845	Phys. Rev., 145: 1095-1102(1966)

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1932-248	20-27846	Phys. Rev., 145: 1103-11(1966)
1932-249	20-27845	Phys. Rev., 145: 1095-1102(1966)
D–	**(Misc.)**	
1-82-0512	20-28485	
DC–	**(Misc.)**	
59-3-90	20-28591	Dep. mn. CFSTI $3.00 cy, $0.75 mn
DOCKET	**(Misc.)**	
50-244(Exh.D)(Vol.1)(App.)	20-28755	See NP-15908(Exh.D)(Vol.1)(App.)
50-244(Exh.D)(Vol.2)(Pt.A)	20-28756	See NP-15908(Exh.D)(Vol.2)(Pt.A)
50-244(Exh.D)(Vol.2)(Pt.B)	20-28757	See NP-15908(Exh.D)(Vol.2)(Pt.B)
DP–		
1027	20-28715	Dep. mn. CFSTI $4.00 cy, $0.75 mn
DPST–		
66-30-1	20-27195	Dep. mn. CFSTI $1.00 cy, $0.50 mn
DUBNA REPORTS	**(Russian)**	
See JINR (Russian)		
DUN–		
800	20-27408	Dep. mn. CFSTI $2.00 cy, $0.50 mn
DUN-SA–		
10	20-27480	Dep. mn. CFSTI $1.00 cy, $0.50 mn
EDR–	**(Misc.)**	
3660	20-27787	See TID-22303
EHE–		
02-6501(Pt.1)	20-26607	See TID-22873
09-6403	20-26608	See TID-22876
11-6502	20-26606	See TID-22870
ETR–	**(Belgian)**	
176	20-27039	See NP-15946
EUR–	**(European Atomic Energy Community)**	
1621.e(Vol.3)	20-28817	Dep. mn
2368	20-27481	See EURAEC-1419 and App.
2399	20-27034	See EURAEC-1479
2634.d	20-26653	Dep. mn
2665	20-27482	See EURAEC-1453
2675	20-28716	See EURAEC-1523
2684	20-27106	See EURAEC-1535
2693	20-27442	See EURAEC-1551
2809	20-27579	See EURAEC-1580
EURAEC–		
1419 and App.	20-27481	Dep. mn. CFSTI $3.00 cy, $0.75 mn
1453	20-27482	Dep. mn. CFSTI $2.00 cy, $0.50 mn
1479	20-27034	Dep. mn. CFSTI $3.00 cy, $0.75 mn
1490	20-28766	See WCAP-3385-51
1492	20-28767	See WCAP-3385-53
1493	20-28768	See WCAP-3385-54
1523	20-28716	Dep. mn. CFSTI $1.00 cy, $0.50 mn
1535	20-27106	Dep. mn. CFSTI $3.00 cy, $0.75 mn
1551	20-27442	Dep. mn. CFSTI $3.00 cy, $0.75 mn
1566	20-27450	See UNC-5144
1580	20-27579	Dep. mn. CFSTI $1.00 cy, $0.50 mn
1598	20-28696	See GEAP-5084
1602	20-27581	See GEAP-5100F
1613	20-28741	Dep. mn. CFSTI $4.00 cy, $0.75 mn
1627	20-27108	See GEAP-5146
1628	20-27107	See GEAP-5142
1629	20-27105	See BAW-3238-12
1630	20-27428	Dep. mn. CFSTI $2.00 cy, $0.50 mn
1631	20-27567	See BMI-1766
1641	20-28685	See BMI-X-10163
1643	20-27488	See IITRI-578P27-17
FEI–	**(Russian)**	
18	20-28484	Dep. mn
27	20-27785	Dep. mn
28	20-28270	Dep. mn
30	20-28268	Dep. mn
FR–	**(Non-AEC)**	
65-10-243	20-27363	See AD-632112
FZK–	**(Non-AEC)**	
272	20-26919	See AD-632666
GA–	**(Misc.)**	
6332	20-27483	Dep. mn. CFSTI $2.00 cy, $0.50 mn
6418	20-28742	Dep. mn. CFSTI $5.00 cy, $1.00 mn
6542	20-27484	Dep. mn. CFSTI $5.00 cy, $1.00 mn
6671	20-28743	Dep. mn. CFSTI $4.00 cy, $0.75 mn
6869	20-28744	Dep. mn. CFSTI $3.00 cy, $0.75 mn
6890	20-28818	
6996	20-27580	Dep. mn. CFSTI $1.00 cy, $0.50 mn
7038	20-28745	Dep. mn. CFSTI $4.00 cy, $0.75 mn
GAMD–	**(Misc.)**	
6525	20-28730	Dep. mn. CFSTI $3.00 cy, $0.75 mn
GEAP–	**(Misc.)**	
4770	20-28731	Dep. mn. CFSTI $5.00 cy, $1.00 mn
4795	20-28746	Dep. mn. CFSTI $3.00 cy, $0.75 mn
4819	20-28732	Dep. mn. CFSTI $4.00 cy, $1.00 mn
4860	20-28747	Dep. mn. CFSTI $3.00 cy, $0.75 mn
4919	20-28733	Dep. mn. CFSTI $2.00 cy, $0.50 mn
4931	20-28748	Dep. mn. CFSTI $3.00 cy, $0.50 mn
4964	20-28694	Dep. mn. CFSTI $4.00 cy, $1.00 mn
4994	20-28830	Dep. mn. CFSTI $4.00 cy, $1.00 mn
5060	20-28749	Dep. mn. CFSTI $2.00 cy, $0.50 mn
5061	20-28750	Dep. mn. CFSTI $3.00 cy, $0.75 mn
5079	20-28233	Dep. mn. CFSTI $1.00 cy, $0.50 mn
5082	20-28695	Dep. mn. CFSTI $3.00 cy, $0.75 mn
5084	20-28696	Dep. mn. CFSTI $4.00 cy, $0.75 mn
5100F	20-27581	Dep. mn. CFSTI $3.00 cy, $0.75 mn
5125	20-28751	Dep. mn. CFSTI $4.00 cy, $0.75 mn
5142	20-27107	Dep. mn. CFSTI $2.00 cy, $0.50 mn
5146	20-27108	Dep. mn. CFSTI $1.00 cy, $0.50 mn
GEMP–	**(Misc.)**	
58A	20-27409	Dep. mn. CFSTI $3.00 cy, $0.75 mn
400A	20-27410	Dep. mn. CFSTI $6.00 cy, $1.50 mn
HASL–		
170	20-27196	Dep. mn. CFSTI $3.00 cy, $0.50 mn
175	20-27197	Dep. mn. CFSTI $1.00 cy, $0.50 mn
HMI-B–	**(German)**	
48	20-26743	Dep. mn
HW–		
72369	20-26816	Dep. mn. CFSTI $1.00 cy, $0.50 mn
72572	20-27431	Dep. mn. CFSTI $1.00 cy, $0.50 mn
73333	20-27412	Dep. mn. CFSTI $1.00 cy, $0.50 mn
75468	20-27413	Dep. mn. CFSTI $1.00 cy, $0.50 mn
83984	20-27444	Dep. mn. CFSTI $1.00 cy, $0.50 mn
HW-SA–		
3099	20-26744	Dep. mn. CFSTI $1.00 cy, $0.50 mn
IAE–	**(Non-AEC)**	
986	20-28831	Dep. mn
991	20-28832	Dep. mn
1007	20-28173	Dep. mn
1016	20-28486	Dep. mn
IBJ–	**(Polish)**	
See INR		
IC–	**(Misc.)**	
65/34	20-28033	Proc. Roy. Soc. (London), Ser. A, 291: No. 1424, 106-12(1966)
66/36	20-27962	Dep. mn
66/37	20-27963	Dep. mn
66/47	20-27801	Dep. mn
66/49	20-27964	Dep. mn
IDO–		
12052	20-28852	Dep. mn. CFSTI $2.00 cy, $0.50 mn
14661	20-27035	Dep. mn. CFSTI $4.00 cy, $0.75 mn
28655	20-28753	Dep. mn. CFSTI $6.00 cy, $1.25 mn

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IFA-FT–	**(Rumanian)**	
56	20-27719	Dep. mn
57	20-28604	Dep. mn
IFA-IS–	**(Rumanian)**	
34	20-26745	Dep. mn
IFJ–	**(Polish)**	
See INP		
IITRI–	**(Misc.)**	
578P27-17	20-27488	Dep. mn. CFSTI $1.00 cy, $0.50 mn
B6035-17	20-27488	See IITRI-578P27-17
INR–	**(Non-AEC)**	
471/IX-A	20-28717	Dep. mn
675/XIII/J	20-27001	Dep.
676/XIII/J	20-27002	Dep. mn
686/III/E	20-27261	Dep.
690/IX-A/R	20-28234	Dep.
IPP–	**(Non-AEC)**	
3/37	20-27786	Dep. mn
IS–		
1136	20-26855	J. Inorg. Nucl. Chem., 28: 971-8(1966)
1217	20-28380	Nucl. Phys., 82: 449-70(1966)
1240	20-27051	J. Inorg. Nucl. Chem., 28: 1119-20(1966)
1243	20-27052	J. Inorg. Nucl. Chem., 28: 1121-2(1966)
1284	20-26834	Inorg. Chem., 5: 761-6(1966)
1285	20-26840	Inorg. Chem., 5: 938-40(1966)
1288	20-26837	Inorg. Chem., 5: 819-22(1966)
1296	20-28658	Phys. Rev., 146: 429-31(1966)
ISO-SA–		
13	20-26746	Dep. mn. CFSTI $1.00 cy, $0.50 mn
ISS–	**(Italian)**	
65/45	20-26638	Dep. mn
66/2	20-27802	Dep. mn
JAERI–	**(Japanese)**	
1101	20-27198	Dep. mn
1103	20-28271	Dep. mn
1104	20-28272	Dep. mn
1105	20-28718	Dep. mn
1106	20-27037	Dep. mn
4036	20-27199	Dep. mn
JAERI-Memo–	**(Japanese)**	
2190	20-28719	Dep. mn
JINR–	**(Russian)**	
E-2644	20-27965	Dep. mn
E-2681	20-27966	Dep. mn
P-2622	20-28605	Dep. mn
P-2625	20-28273	Dep. mn
P-2633	20-28592	Dep. mn
P-2636	20-27720	Dep. mn
P-2638	20-27967	Dep. mn
P-2642	20-28141	Dep. mn
P-2647	20-28274	Dep. mn
P-2648	20-28487	Dep. mn
P-2651	20-28275	Dep. mn
P-2657	20-27644	Dep. mn
P-2661	20-27262	Dep. mn
P-2664	20-28276	Dep. mn
P-2665	20-27968	Dep. mn
JPRS–	**(Non-AEC)**	
35011	20-26658	CFSTI $2.00 cy, $0.50 mn
JUL–	**(German)**	
313-20	20-26654	Dep. mn
314-PP	20-28488	Dep. mn
316-RE	20-28834	Dep. mn
321-RG	20-28752	Dep. mn
333-RE	20-28835	Dep. mn
337-RG	20-28277	Dep. mn
338-NP	20-28836	Dep. mn
339-PP	20-28489	Dep. mn
354-RG	20-28278	Dep. mn
355-RX	20-28279	Dep. mn
K–		
1663	20-27200	Dep. mn. CFSTI $1.00 cy, $0.50 mn
1666	20-27038	Dep. mn. CFSTI $2.00 cy, $0.50 mn
KFK–	**(German)**	
403	20-27645	Dep. mn
LA–		
3448	20-28819	Dep. mn. CFSTI $2.00 cy, $0.50 mn
3473	20-26817	Dep. mn. CFSTI $2.00 cy, $0.50 mn
3481	20-26818	Dep. mn. CFSTI $1.00 cy, $0.50 mn
3487	20-28490	Dep. mn. CFSTI $5.00 cy, $1.00 mn
LA-DC–		
6807	20-27489	Dep. mn. CFSTI $1.00 cy, $0.50 mn
6822	20-27588	Dep. mn. CFSTI $2.00 cy, $0.50 mn
6901	20-27490	Dep. mn. CFSTI $1.00 cy, $0.50 mn
7033	20-26911	pp 99-105 of Chemistry Session C. Book Three [of Preprints of] Fifth Rare Earth Research Conference, Aug. 30–Sept. 1, 1965
7033(Rev.)	20-26911	See LA-DC-7033
7143	20-26747	Dep. mn. CFSTI $1.00 cy, $0.50 mn
7159	20-27445	Dep. mn. CFSTI $2.00 cy, $0.50 mn
7161	20-27491	Dep. mn. CFSTI $1.00 cy, $0.50 mn
7244	20-28820	Dep. mn. CFSTI $2.00 cy, $0.50 mn
7272	20-27077	Dep. mn. CFSTI $2.00 cy, $0.50 mn
7499	20-28631	Nucl. Instrum. Methods, 41: 133-4(1966)
7561	20-28606	Dep. mn. CFSTI $1.00 cy, $0.50 mn
7590	20-27201	Dep. mn. CFSTI $2.00 cy, $0.50 mn
7641	20-28821	Dep. mn. CFSTI $1.00 cy, $0.50 mn
7649	20-28822	Dep. mn. CFSTI $1.00 cy, $0.50 mn
7651	20-27244	Rev. Sci. Instrum., 37: 762-7(1966)
7655	20-27132	Dep. mn. CFSTI $1.00 cy, $0.50 mn
7656	20-27133	Dep. mn. CFSTI $2.00 cy, $0.50 mn
7697	20-27678	Rev. Sci. Instrum., 37: 755-62(1966)
7753	20-28754	Dep. mn. CFSTI $2.00 cy, $0.50 mn
LAC-ER–	**(Non-AEC)**	
8434	20-27589	See NASA-CR-54881
LB–	**(Non-AEC)**	
31693	20-28040	See AD-609534
LNF–	**(Italian)**	
66/12	20-27228	Dep. mn
66/17	20-27803	Dep. mn
LRP–	**(Swiss)**	
24/66	20-27623	Dep. mn
LYCEN–	**(French)**	
6610	20-28280	Dep. mn
MAB–	**(Non-AEC)**	
206-M(3)	20-27446	CFSTI $2.00 cy, $0.50 mn
MATT-Q–		
22	20-28491	Dep. mn. CFSTI $7.06 cy, $1.75 mn
MIT–	**(Misc.)**	
334-48	20-26924	Dep. mn. CFSTI $2.00 cy, $0.50 mn
905-38	20-26867	J. Phys. Chem., 70: 1365-71(1966)
2098-215	20-28336	Nucl. Phys., 81: 390-400(1966)
MITNE–	**(Misc.)**	
75	20-26924	See MIT-334-48
MURA–	**(Misc.)**	
718	20-27766	Dep. mn. CFSTI $1.00 cy, $0.50 mn
NAA-SR–		
11355	20-27263	Dep. mn. CFSTI $1.00 cy, $0.50 mn
11821	20-28235	Dep. mn. CFSTI $2.00 cy, $0.50 mn
NASA-CR–	**(Misc.)**	
471	20-27492	CFSTI $2.00 cy, $0.50 mn
54881	20-27589	

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54892	20-27432	
54909	20-28818	See GA-6890
54918	20-27493	
54935	20-27497	See WANL-PR-(Q)-009
54954	20-28265	See AI-66-85
NASA-TN–	**(Misc.)**	
D-3427	20-27364	CFSTI $1.00 cy, $0.50 mn
NBL–		
233	20-26748	Dep. mn. CFSTI $1.00 cy, $0.50 mn
NDL-TR–	**(Non-AEC)**	
66	20-27185	See AD-632989
NEVIS–	**(Misc.)**	
142	20-27846	Phys. Rev., 145: 1103-11(1966)
143	20-27845	Phys. Rev., 145: 1095-1102(1966)
NMI–	**(Misc.)**	
1264	20-27447	Dep. mn. CFSTI $6.00 cy, $1.25 mn
NML–	**(Non-AEC)**	
64-2	20-26819	
NP–	**(AEC File No. for Non-AEC Reports)**	
15878	20-27646	Dep. mn
15879	20-27264	Dep. mn
15908(Exh.D) (Vol.1)(App.)	20-28755	Dep. mn. CFSTI $6.00 cy, $1.25 mn
15908(Exh.D) (Vol.2)(Pt.A)	20-28756	Dep. mn. CFSTI $5.00 cy, $1.00 mn
15908(Exh.D) (Vol.2)(Pt.B)	20-28757	Dep. mn. CFSTI $5.00 cy, $1.00 mn
15946	20-27039	Dep. mn. CFSTI $3.00 cy, $0.50 mn
15961	20-27121	Dep. mn
15975	20-26655	Dep. mn
15976	20-28864	Dep. mn
16002	20-26596	Dep. mn
16007	20-28496	Dep. mn
16008	20-27647	Dep. mn
16009	20-27648	Dep. mn
16011	20-27649	Dep. mn
16013	20-27650	Dep. mn
16037	20-26925	Dep. mn
16039	20-28236	Dep. mn
16041	20-27202	Dep. mn
NP-tr–	**(AEC File No. for Non-AEC Translations)**	
1380	20-27721	Dep. mn. CFSTI $1.00 cy, $0.50 mn; JCL $1.10 fs, $0.80 mf
1382	20-26718	Dep. mn. JCL $3.60 fs, $1.37 mf
NRC–	**(Canadian)**	
8918	20-27767	Can. J. Phys., 44: 1121-45(1966)
NRL–	**(Misc.)**	
6374	20-27205	Dep. mn. CFSTI $1.00 cy, $0.50 mn
NYO–		
1679-15	20-28342	Nucl. Phys., 81: 449-67(1966)
1932-103	20-27841	Phys. Rev., 145: 1018-22(1966)
2471-21	20-28607	Dep. mn. CFSTI $1.00 cy, $0.50 mn
2784-11	20-27447	See NMI-1264
2983-1	20-27229	Dep. mn. CFSTI $3.00 cy, $0.75 mn
3270-2(Vol.1)	20-28758	Dep. mn. CFSTI $7.00 cy, $1.75 mn
3270-2(Vol.2)	20-28759	Dep. mn. CFSTI $6.00 cy, $1.50 mn
3270-2(Vol.3)	20-28760	Dep. mn. CFSTI $6.00 cy, $1.50 mn
3280-1(Vol.1) (Bk.1)	20-28761	Dep. mn. CFSTI $13.21 cy, $4.25 mn
3361-6	20-26656	ORAU
3369-8	20-26758	Anal. Chem., 38: 810-13(1966)
3399-58	20-28003	Phys. Lett., 21: 106-8(1966)
3408-5	20-28608	Dep. mn. CFSTI $1.00 cy, $0.50 mn
3408-6	20-28609	Dep. mn. CFSTI $1.00 cy, $0.50 mn
3446-5	20-27206	Dep. mn. CFSTI $1.00 cy, $0.50 mn
3454-6	20-27494	Dep. mn. CFSTI $3.00 cy, $0.75 mn
ORNL–		
3831	20-27040	Dep. mn. CFSTI $6.00 cy, $1.25 mn
3930	20-27590	Dep. mn. CFSTI $3.00 cy, $0.75 mn
3943	20-28686	Dep. mn. CFSTI $3.00 cy, $0.75 mn
3952	20-27041	Dep. mn. CFSTI $2.00 cy, $0.50 mn
3962	20-28812	Dep. mn. CFSTI $3.00 cy, $0.75 mn
ORNL-NSIC–		
16	20-27207	Dep. mn. CFSTI $6.00 cy, $1.25 mn
ORNL-P–	**(Misc.)**	
1285	20-26806	Radiochim. Acta, 5: 18-20(1966)
1381	20-28823	Dep. mn. CFSTI $1.00 cy, $0.50 mn
1416	20-27433	Dep. mn. CFSTI $2.00 cy, $0.50 mn
1509	20-26858	J. Inorg. Nucl. Chem., 28: 1055-61(1966)
1583	20-26859	J. Inorg. Nucl. Chem., 28: 1063-6(1966)
1662	20-27600	Electrochem. Technol., 4: 237-9(1966)
1686	20-27814	Nucl. Phys., 82: 690-4(1966)
1693	20-28059	J. Appl. Phys., 37: 2276-8(1966)
1720	20-28216	Rev. Sci. Instrum., 37: 734-6(1966)
1776	20-26868	J. Phys. Chem., 70: 1511-15(1966)
1819	20-27551	Trans. Met. Soc. AIME, 236: 686-94(1966)
1832	20-26869	J. Phys. Chem., 70: 1633-6(1966)
1862	20-28344	Nucl. Phys., 81: 481-522(1966)
1876	20-28857	Nucl. Eng. Design, 3: 432-8(1966)
1892	20-27124	Nucl. Eng. Design, 3: 256-80(1966)
1986	20-28837	Dep. mn. CFSTI $1.00 cy, $0.50 mn
1999	20-27043	Anal. Chem., 38: 905-6(1966)
2046	20-28402	Phys. Lett., 21: 64-6(1966)
2074	20-28281	Dep. mn. CFSTI $1.00 cy, $0.50 mn
2091	20-28282	Dep. mn. CFSTI $2.00 cy, $0.50 mn
2108	20-27414	Dep. mn. CFSTI $2.00 cy, $0.50 mn
2113	20-27834	Phys. Lett., 21: 347-9(1966)
ORNL-TM–		
1311	20-27109	Dep. mn. CFSTI $3.00 cy, $0.75 mn
1347	20-27545	Trans. Amer. Soc. Metals, 59: 277-87(1966)
1386	20-28687	Dep. mn. CFSTI $2.00 cy, $0.50 mn
1427	20-27591	Dep. mn. CFSTI $3.00 cy, $0.75 mn
1461	20-27448	Dep. mn. CFSTI $2.00 cy, $0.50 mn
1474	20-27592	Dep. mn. CFSTI $3.00 cy, $0.75 mn
1475	20-27392	Dep. mn. CFSTI $1.00 cy, $0.50 mn
1478	20-27208	Dep. mn. CFSTI $1.00 cy, $0.50 mn
1532	20-28838	Dep. mn. CFSTI $1.00 cy, $0.50 mn
ORNL-tr–		
961	20-27499	Dep. mn. JCL $1.60 fs, $0.80 mf
1234	20-26661	Dep. mn. CFSTI $1.00 cy, $0.50 mn; JCL $1.10 fs, $0.80 mf
1236	20-27594	Dep. mn. JCL $1.10 fs, $0.80 mf
PAN–	**(Polish)**	**(This series of reports was terminated in 1965. Subsequent reports are identified by the code INR.)**
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721,224	20-27422	
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723,261	20-28705	
730,258	20-28690	
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1,208,423	20-28711	
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1,208,830	20-27253	

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1,208,834	20-28712	
1,208,835	20-27684	
1,209,668	20-27358	
1,209,669	20-27359	
1,209,670	20-28590	
1,210,494	20-27085	
1,212,646	20-27360	
1,213,063	20-27361	
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3,242,844	20-27127	
3,243,147	20-27223	
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3,249,800	20-27255	
PD–	**(Canadian)**	
261	20-28283	Dep. mn
PG-Report–	**(British)**	
695	20-26749	Dep. mn. BIS $0.20. HMSO 1s. 2d.
700	20-26750	Dep. BIS $0.50. HMSO 2s. 6d.
PNE–		
481	20-28865	OTS or GPO
PPAD–		
578-E	20-27833	Phys. Lett., 21: 343-7(1966)
PRNC–		
26	20-27265	Dep. mn. CFSTI $2.00 cy, $0.50 mn
84	20-28610	Dep. mn. CFSTI $3.00 cy, $0.50 mn
R–	**(Misc.)**	
532	20-27846	Phys. Rev., 145: 1103-11(1966)
534	20-27845	Phys. Rev., 145: 1095-1102(1966)
R-OU–	**(Non-AEC)**	
197	20-27184	See AD-632865
RAC–	**(Non-AEC)**	
1478	20-26751	
RD-TR–	**(Non-AEC)**	
63-607	20-26751	See RAC-1478
RFP–		
706	20-27495	Dep. mn. CFSTI $2.00 cy, $0.50 mn
735	20-28854	Dep. mn. CFSTI $2.00 cy, $0.50 mn
765	20-26752	Dep. mn. CFSTI $1.00 cy, $0.50 mn
RHEL-R–	**(British)**	
114	20-27266	Dep. mn. BIS $0.50. HMSO 2s. 6d.
RISO–	**(Danish)**	
121	20-27145	Dep. mn
RISO-M–	**(Danish)**	
392	20-27399	Dep. mn
RL-SA–		
44	20-28816	Dep. mn. CFSTI $1.00 cy, $0.50 mn
RLE-QPR–		
81	20-27624	See TID-22956
RLO–		
244-1	20-27007	Inorg. Chem., 5: 911-16(1966)
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1388-5	20-28284	Dep. mn. CFSTI $1.00 cy, $0.50 mn
1921-5	20-28328	Nucl. Phys., 81: 296-304(1966)
RM–	**(Misc.)**	
4910-TAB	20-27209	Dep. mn. CFSTI $3.00 cy, $0.50 mn
RSIC–	**(Non-AEC)**	
534	20-27230	
RT-FI–	**(Italian)**	
(65)-61	20-28042	Dep. mn
SC-CR–		
66-2015	20-27134	Dep. mn. CFSTI $2.00 cy, $0.50 mn
66-2019	20-26820	Dep. mn. CFSTI $6.00 cy, $1.25 mn
SC-DC–		
3127A	20-27365	ORAU
SC-DR–		
66-99	20-27400	Dep. mn. CFSTI $2.00 cy, $0.50 mn
SC-RR–		
66-134	20-27434	Dep. mn. CFSTI $1.00 cy, $0.50 mn
SLAC–		
56	20-27078	Dep. mn. CFSTI $3.00 cy, $0.50 mn
SLAC-PUB–		
173	20-28024	Phys. Rev. Lett., 16: 964-7(1966)
SLAC-Trans–		
40	20-28611	Dep. mn. JCL $1.60 fs, $0.80 mf
SRIA–		
106-38	20-26821	Dep. mn. CFSTI $1.00 cy, $0.50 mn
115P53-1	20-26657	Dep. mn. CFSTI $2.00 cy, $0.50 mn
STI-DOC–	**(International Atomic Energy Agency)**	
10/49	20-28762	IAEA: $3.50; S73,50; £1.1.0; F Fr 14,-; DM 12,25
SWRI–		
1228-4-17	20-27449	Dep. mn. CFSTI $3.00 cy, $0.75 mn
TID–		
4100(Suppl.33)	20-27070	Dep. DTI Extension Free
22018	20-28285	Dep. mn. CFSTI $1.00 cy, $0.50 mn
22114	20-26610	Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur., 38: 948-59(1965)
22149	20-27726	Astrophys. J., 144: 369-75(1966)
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22303	20-27787	Dep. mn. CFSTI $4.00 cy, $1.00 mn
22367	20-28348	Nucl. Phys., 81: 575-84(1966)
22729	20-27618	Phys. Rev., 146: 480-5(1966)
22816	20-28560	Phys. Lett., 21: 45-7(1966)
22844	20-28286	Dep. mn. CFSTI $3.00 cy, $0.75 mn
22870	20-26606	Dep. mn. CFSTI $5.00 cy, $1.00 mn
22873	20-26607	Dep. mn. CFSTI $3.00 cy, $0.75 mn
22876	20-26608	Dep. mn. CFSTI $4.00 cy, $0.75 mn
22936	20-28593	Dep. mn. CFSTI $3.00 cy, $0.75 mn
22956	20-27624	Dep. mn. CFSTI $6.00 cy, $1.50 mn
22966	20-26822	Dep. mn. CFSTI $1.00 cy, $0.50 mn
TF–	**(Misc.)**	
1307	20-28825	See AD-627807
TRG–	**(Misc.)**	
215-FR	20-28593	See TID-22936
TRG-Inf.Ser.–	**(British)**	
312	20-27415	Dep. BIS $2.60. HMSO 13s.
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TT–	**(Canadian)**	
66-31449	20-26658	See JPRS-35011
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11217	20-27742	Phys. Rev., 146: 9-16(1966)
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14293-T(Rev.1)	20-27268	Dep. mn. CFSTI $2.00 cy, $0.50 mn
14526	20-27738	Phys. Rev., 145: 23-4(1966)
14584	20-28339	Nucl. Phys., 81: 423-32(1966)
14593	20-27231	Dep. mn. CFSTI $1.00 cy, $0.50 mn
14619	20-28866	Dep. mn. CFSTI $2.00 cy, $0.50 mn
14654-T	20-27170	Dep. mn. CFSTI $2.00 cy, $0.50 mn
14680	20-27210	Dep. mn. CFSTI $2.00 cy, $0.50 mn
14687-T	20-27830	Phys. Lett., 21: 314-18(1966)
14752	20-28867	Dep. mn. CFSTI $1.00 cy, $0.50 mn
14805	20-27496	Dep. mn. CFSTI $1.00 cy, $0.50 mn
14848-T	20-27125	Dep. mn. CFSTI $2.00 cy, $0.50 mn
14885-T	20-27969	Dep. mn. CFSTI $1.00 cy, $0.50 mn
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16249	20-26823	A.I.Ch.E. (Amer. Inst. Chem. Eng.) J., 12: 693-9(1966)
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16421	20-28337	Nucl. Phys., 81: 401-16(1966)
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16515	20-27321	Nucl. Instrum. Methods, 41: 161-3(1966)
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16600	20-26759	Anal. Chem., 38: 813-18(1966)
16767	20-27804	Dep. mn. CFSTI $1.00 cy, $0.50 mn
16768	20-28289	Dep. mn. CFSTI $2.00 cy, $0.50 mn
16804	20-27788	Dep. mn. CFSTI $1.00 cy, $0.50 mn
16805	20-27789	Dep. mn. CFSTI $1.00 cy, $0.50 mn
UCRL-Trans.–		
10036	20-27417	Dep. mn. CFSTI $7.00 cy, $1.50 mn; JCL $19.75 fs, $9.32 mf
UNC–	**(Misc.)**	
5134(Vol.1)	20-27416	Dep. mn. CFSTI $4.00 cy, $0.75 mn
5134(Vol.2)	20-27593	Dep. mn; CFSTI $5.00 cy, $1.25 mn
5144	20-27450	Dep. mn. CFSTI $3.00 cy, $0.75 mn
UR–		
875-130	20-27870	Phys. Rev. Lett., 16: 947-50(1966)
USC–		
136-107	20-27852	Phys. Rev., 145: 1164-5(1966)
USNRDL-TR–	**(Misc.)**	
991	20-27211	Dep. mn. CFSTI $2.00 cy, $0.50 mn
992	20-28262	See AD-632242
999	20-26651	See AD-632282
1004	20-26652	See AD-632540
USNRDL-TRC–	**(Non-AEC)**	
19	20-27363	See AD-632112
WANL-PR–	**(Misc.)**	
(Q)-009	20-27497	
WANL-TME–	**(Misc.)**	
967	20-27110	Dep. mn. CFSTI $3.00 cy, $0.50 mn
WAPD-MRP–		
116	20-28764	Dep. mn. CFSTI $4.00 cy, $0.75 mn
WAPD-T–		
1757	20-27498	Dep. mn. CFSTI $2.00 cy, $0.50 mn
WAPD-TM–	**(Misc.)**	
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